

MIDDLE SCHOOL GIRLS' STEM EDUCATION: USING TEACHER INFLUENCES,  
PARENT ENCOURAGEMENT, PEER INFLUENCES, AND SELF EFFICACY TO PREDICT  
CONFIDENCE AND INTEREST IN MATH AND SCIENCE

by

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## **ABSTRACT**

Reports are clear that there is an underrepresentation of women in science, technology, engineering, and mathematics (STEM) careers. With the current and predicted future shortage of STEM workforce, it is more important than ever to encourage young women to enter these important fields of study. Using Bronfenbrenner's Bioecological Model, possible predictors of middle school girls' confidence and interest in math and science were explored. The factors in this study included the macrosystems of age and race/ethnicity and the microsystems of self-efficacy, teacher influences, parent encouragement, and peer influences. Sequential regression analysis results revealed that self-efficacy was a significant predictor for confidence in math and science. While, math/science teacher influences and peer influences were significant predictors of interest and confidence in both math and science. Sequential regression analysis also indicated age was a significant predictor of math interest. The results of this study provides information on the systemic connections among the variables and suggestions on how to impact middle school girls' STEM development, thus impacting the future STEM workforce.



## CHAPTER 1

### INTRODUCTION

*In 1979, women accounted for 9% of the science and engineering workforce; in 1988 that increased to 16%. However, women are 45% of the total work force.*  
*National Science Board*

Although reports are showing more women entering into the STEM career fields, there continues to be significant underrepresentation of women in these fields. According to Jones (2010), approximately 1% of women were represented in the engineering fields in 1960, and in 2000 the percentage of women in the engineering field had only increased to 11%. There has also been an incongruity in women receiving degrees in other STEM areas. The National Science Foundation (2008) reported that women accounted for only 26.8% of the degrees earned in mathematics and computer sciences in 2006. Between 2000 and 2009, the U.S. Department of Commerce, Economic and Statistics Administration (2011) reported a 0% gain in college-educated women in STEM employment. With women remaining at 24% of the STEM workforce from 2000 to 2009, this report also indicates a decrease in women in computer science and math by 3%, and increase in engineering of 1%, and an increase in STEM field managers of 2%.

According to AAUW (2010), “attracting and retaining more women in the STEM workforce will maximize innovation, creativity, and competitiveness” (p. 3). The AAUW (2010) further reports the need for women in STEM careers to diversify thinking when finding cures for disease and engineering buildings. A lack of women in these important fields where many products are created will cause women’s needs to be overlooked. When the workforce is more diverse, it is more likely that products and services will represent all consumers.

Although the research shows a slight increase of women entering into the STEM career fields over the past 50 years, there continues to be far fewer numbers of women in the STEM career fields as compared to men. A few reasons why women are in the minority in STEM career paths include social, cultural, educational and self-confidence factors as pointed out in a recent report by the American Association of University Women (2010). These factors must be addressed while female students are young in order to make an impact on their future career choice. Heaverlo (2011) suggests “to increase the number of girls pursuing STEM fields, it is important to find successful strategies that encourage their interest and affirm their confidence in the areas of science and mathematics” (p. 84).

According to the White House Council on Women and Girls (2012), only 25% of the STEM workforce is currently comprised of women. This report indicates two primary reasons for this figure:

- Women are enrolling in STEM fields at a lower rate than men.
- Women who obtain degrees in STEM fields go on to work in other career areas.

The U.S. Bureau of Labor Statistics (2012) predicts that there will be a substantial increase in positions open in STEM career fields by 2018. Therefore, it is imperative that more girls and other underrepresented populations in STEM fields are encouraged and supported to aspire toward STEM careers.

President Obama has provided states with Race to the Top funding for working toward closing the STEM achievement gaps. According to the U.S. Department of Education, Race to the Top initiatives requires states to make school reform around the following specific areas:

- Adopting standards and assessments that prepare students to succeed in college and the workplace and to compete in the global economy;

- Building data systems that measure student growth and success, and inform teachers and principals about how they can improve instruction;
- Recruiting, developing, rewarding, and retaining effective teachers and principals, especially where they are needed most; and
- Turning around our lowest-achieving schools.

The efforts at the national level are admirable; however, not all states have secured the Race to the Top funding. Iowa is one of those states. Due to the low numbers of participation in STEM programs, activities, degrees, and careers in Iowa, the Governor of Iowa, established a STEM advisory council. This council is comprised of 40 board members who serve a 3 year term advising the Governor on the improvement of education and careers in STEM. The individuals serving on this committee have backgrounds in education, the legislature, and STEM businesses.

The STEM advisory council has proposed an education roadmap consisting of seven targets:

Target 1: Increased interest and performance of Iowa learners in STEM fields

Target 2: Increased emphasis on STEM fields in Iowa from Pre-K through 20

Target 3: More high quality STEM teachers prepared by Iowa's institutions of higher education

Target 4: An Iowa citizenry that recognizes the importance of STEM in leading productive lives and creating/sustaining vibrant economy

Target 5: A national leader in STEM workforce preparation and retention in STEM careers

Target 6: Wide-scale partnership of Iowa's education systems and private enterprise

Target 7: Coordinated, complementary and uniform STEM education opportunities across Iowa (IA STEM Scale Up, 2012).

### **Statement of the Problem**

According to the President's Council of Advisors on Science and Technology (2010), the United States falls behind in both elementary and secondary education with underrepresentation by groups such as African Americans, Hispanics, Native Americans, and women. This report explains that schools lack teachers who know how to teach science and math well and fail to inspire students into these career fields. In addition, these teachers lack the professional development and the appropriate tools to create successful science and math programming (President's Council of Advisors on Science and Technology, 2010).

According to Change the Equation's STEM Vital Signs (2011), STEM jobs are anticipated to grow in Iowa from 57,830 positions to 67,330 by 2018, which is a 16% increase. Change the Equation's STEM Vital Signs (2011) also indicates that education in Iowa is failing to prepare girls for these careers showing a decrease in enrollment in pre-engineering programs such as Project Lead the Way. In one year, the enrollment in this program decreased by nearly 2%. The Iowa Commission on the Status of Women (2011) reports that women make up approximately 15% of college freshmen with a STEM major. When compared with the current national STEM college and workforce statistics for women, Iowa is falling below the national statistics which are already discouraging for girls and women in STEM.

Women in STEM careers in Iowa also face a wage disparity indicated nationally. The Iowa Commission on the Status of Women (2012) reports the following findings conducted by the American Community Survey on STEM careers in Table 1.1.

Table 1.1

*Salary Discrepancies between Men and Women in STEM Careers*

Occupation	Males	Females
Computer and mathematical occupations	\$60,000	\$47,000
Architecture and engineering occupations	\$60,478	\$41,790
Life, physical, and social science occupations	\$55,341	\$39,607
Healthcare practitioner and technical occupations	\$77,886	\$41,489
Health diagnosing and treating practitioner and Other technical occupations	\$100,000+	\$46,099
Healthcare support occupations	\$25,932	\$24,099

Iowa Commission on the Status of Women (2012)

Because students often decide what career field they intend to enter between 8<sup>th</sup> grade and 10<sup>th</sup> grade, it is vital to explore adolescent girls' perceptions of STEM education (Gibbons & Borders, 2010).

### **Purpose**

The purpose of this study was to explore potential predictors that influence middle school girls' interests and confidence in math and science. Determining specific factors that influence girls' interest in math and science such as self-efficacy, teacher influences, peer influences, and parental encouragement will provide valuable information to educators and parents. Information gained can be used to guide development of programs and policies that work toward encouraging girls' involvement and retention in STEM programs and activities.

### **Research Questions**

The following research questions guided this study:

1. What are the demographics of the middle school girls who participated in this research?
2. Is there a statistically significant difference between middle school girls' a) confidence in math and interest in math, and b) confidence in science and interest in science?

3. To what extent do age, race/ethnicity, self-efficacy, parental encouragement, peer influence, and math teacher influence predict middle school girls' (6-7<sup>th</sup> grade) interest in math?
4. To what extent do age, race/ethnicity, self-efficacy, parental encouragement, peer influence, and science teacher influence predict middle school girls' (6-7<sup>th</sup> grade) interest in science?
5. To what extent do age, race/ethnicity, self-efficacy, parental encouragement, peer influence, and math teacher predict middle school girls' (6-7<sup>th</sup> grade) confidence in math?
6. To what extent do age, race/ethnicity, self-efficacy, parental encouragement, peer influence, and science teacher predict middle school girls' (6-7<sup>th</sup> grade) confidence in science?

### **Conceptual Framework**

A conceptual Framework as described by Camp (2001), “begins with a supportable premise and then extends that premise through a logical path of reported research and clear reasoning to form the basis for the study” (p. 18). When this premise is met, the conceptual framework is a viable theoretical framework. Camp (2001) suggests that determining a conceptual framework is more than simply citing the theoretical concepts but instead is identifying and summarizing the theoretical assumptions that comprise the basis of the study.

This study is grounded in Bronfenbrenner's (2005) Bioecological model. This theory helps to explain the impact of hypothesized influences on middle school girls' interest and confidence in STEM education subject areas such as math and science. Specifically, in this study this theory is utilized to address the relationship between the factors of self-efficacy, parental encouragement, teacher influences, and peer influences on 6-7<sup>th</sup> grade girls' confidence

and interest in math and science. Bronfenbrenner's (2005) model consists of five systems of sociocultural development including the microsystem, mesosystem, exosystem, macrosystem, and chronosystem. The model suggests that even though time changes, there are relationships in the model that remain constant and have specific defining properties described as propositions (Bronfenbrenner, 2005).

The first proposition focuses on the experiences of the individual and explains that the external factors influencing human behavior are both objective and subjective in nature. Both of these phenomenological and experiential elements work interdependently to impact human development. The second proposition describes the importance of proximal process in the evolution of the biopsychological human organism. Proximal processes are those "activities that occur on a fairly regular basis over extended periods of time" (Bronfenbrenner, 2005 p. 6). In the third proposition, Bronfenbrenner (2005) suggests that "form, power, content, and direction of the proximal processes producing development vary systematically as a joint function of the characteristics of the developing person" (p. 6). Proposition four describes the child's development as dependent upon participation in more complex activities with people the child has a strong relationship with over an extended period of time. Proposition five suggests that the child is internally motivated by the affection received from parents. Finally, proposition six focuses on the patterns of complex interaction and how the child establishes and maintains those relationships (Bronfenbrenner, 2005). With the propositions acting as a driving force in the model, the model can be broken down into specific systems.

The first system is the microsystem, which consist of the settings in which an individual lives including family, peers, school and the neighborhood (Bronfenbrenner, 2005, 1994). This

system is not passive but is constructed by the individual. In this study, the microsystems include self-efficacy of the student, parental influences, teacher influences, and peer influences.

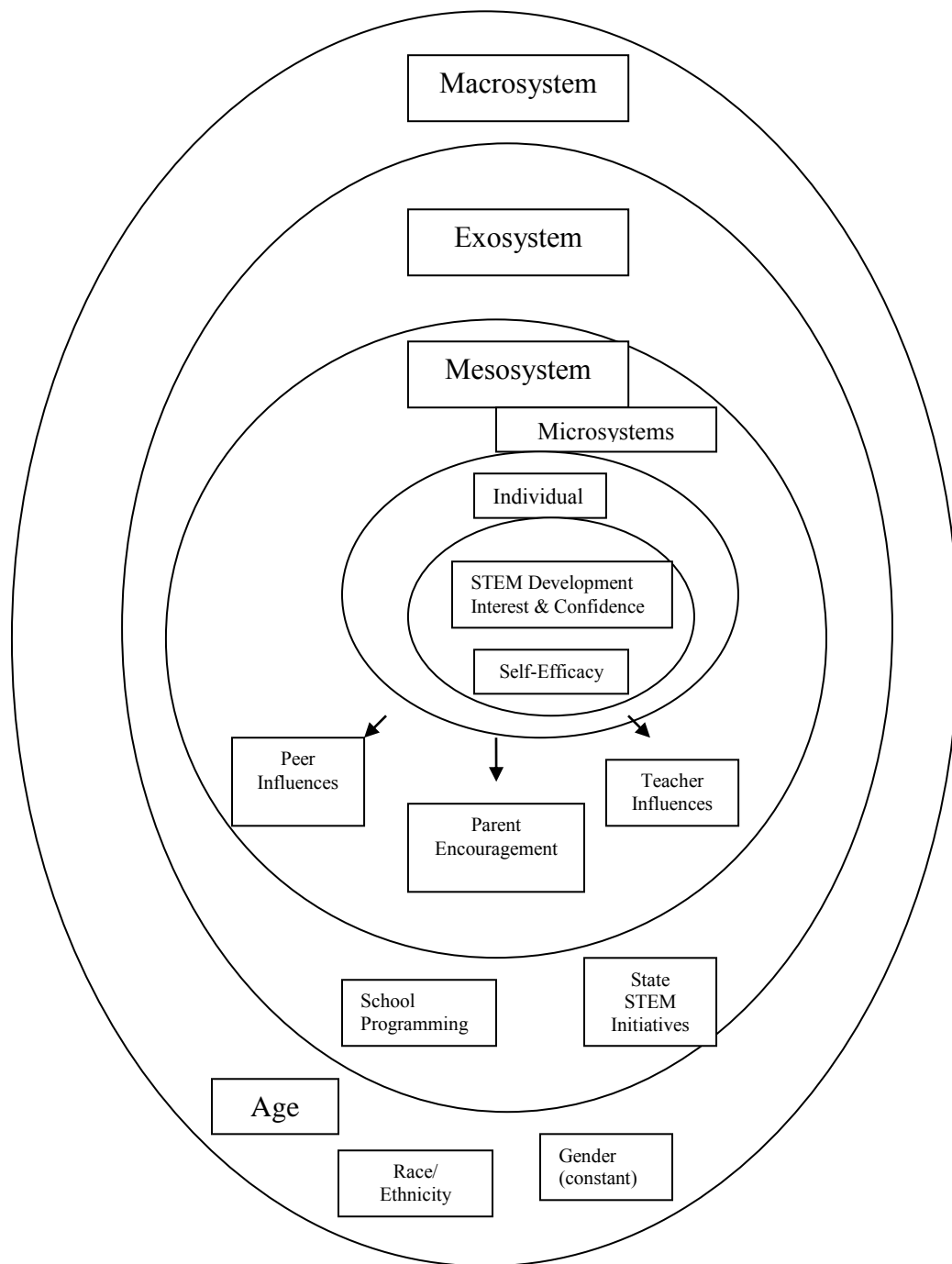
A mesosystem includes the relationships and connections between the microsystems (Bronfenbrenner, 2005, 1994). In this study, the relationships between teacher influences, parental influences, and peer influences are examined to determine the extent to which they have an impact on girls' confidence and interest in math and science.

Exosystems consist of the connections between two or more environments that indirectly impact the environment in which the child lives (Bronfenbrenner, 2005, 1994). An example of this includes the impact that a parent's workplace has on the home which will ultimately affect the child (Bronfenbrenner, 1994). This study did not identify specific exosystem variables to measure.

Macrosystems are comprised of a pattern of relationships between the previous three systems that shapes the "belief systems, bodies of knowledge, material resources, customs, lifestyles, opportunity structures, hazards, and life course options that are embedded in each of these broader systems" (Bronfenbrenner, 1994, p. 47). Bronfenbrenner (2005) noted that gender could be considered a macrosystem. In this study, race/ethnicity, age, and gender are macrosystems. Gender as a macrosystem in this study is not measured because of the specific focus on girls.

Chronosystems focus on the interaction over time between the characteristics of the person and the environment in which they live (Bronfenbrenner, 2005, 1994). Examples of these characteristics include socioeconomic status, employment, etc. Because this study is a cross-sectional design, effects of the chronosystem are not addressed. Figure 1.1 provides a visual illustration of the variables identified in this study and how they are situated in Bronfenbrenner's model.





*Figure 1.1* Girl's Confidence and Interest in Math and Science – Adaptation of Bronfenbrenner's (2005) Bioecological Model

### **Significance of the Study**

The significance of this study is grounded in Bronfenbrenner's findings regarding the relationship between outside influences on the individual. This study targeted those external factors that impact middle school (grades 6-7) girls' interest and confidence in science and math. Determining which factors have an impact on middle school girls' interest and confidence in math and science will be beneficial in the following ways:

- Educators will have a better understanding of how to design instruction that will help to encourage interest and develop the confidence of middle school girls in math and science.
- Programs can be developed to help parents encourage their girls to explore and pursue careers that involve math and science skills (e.g., STEM fields).
- Students, parents, and educators will have a better understanding of peers' influence on girls' decision-making in class choices.

### **Definitions and Key Acronyms**

**STEM** – Science, Technology, Engineering, and Mathematics

**Confidence**- Confidence refers to strength of belief but does not necessarily specify what the certainty is about (Bandura, 1997).

**Efficacy**- Refers to the belief in one's capabilities, that one can produce a certain level of attainment (Bandura, 1997).

**Interest**- For this study, interest is defined as wanting to learn more about the subject.

**Teacher Influences**- Construct created from a factor analysis of survey questions related to teacher practices.

**Peer Influences**- Construct created from a factor analysis of survey questions related to peers.

**Parent Encouragement**- Construct created from a factor analysis of survey questions related

to parents.

### **Summary**

This study explored the factors that influence middle school girls' confidence and interest in math and science. The information gained from this study will help educators, parents and students understand the impact of these factors as they ultimately relate to middle school girls' interest in STEM careers.

Chapter 2 provides a review of the literature supporting the hypothesized relationships between factors influencing girls' interest in math and science. Additionally, chapter 2 explores current conditions of education in Iowa for girls in terms of STEM education.

Chapter 3 focuses on the methodology of the study. This chapter provides a clear picture of the study which includes a statement of the research questions, an explanation of the research design, methodological approach, setting, population/sample, data collection, instrumentation, variables, and data analysis. Conclusively, this chapter describes the limitations and delimitations of the study.

Chapter 4 provides a detailed account of the results of the study. The demographics were reported using descriptives of the participants. Also, paired samples *t*-tests were conducted in order to determine the difference between the participants' confidence and interest in math and science. After the *t*-tests were complete, correlations were run in order to explore the relationships between each of variables. Then sequential multiple regressions were conducted to determine the predictors of middle school girls' interest and confidence in math and science.

Chapter 5 offers a summary of the study by chapter and then discusses the results. This chapter also discusses the implications for policy and practice and provides recommendations for future research in this area of study.

## CHAPTER 2

### LITERATURE REVIEW

*“The perception of engineering and science is really still that stereotypical nerd image. The image some girls will tell me about when they think about a computer scientist is a nerdy boy sitting in a basement eating donuts with really greasy hair. The truth is, they don’t really find that all that appealing.” (p. 1)*

*Hopkins (2012)*

*How to Encourage Women to Consider STEM Majors*

Chapter two describes the historical perspective as it relates to STEM education beginning in the early 1900s. Also addressed in this chapter is the local perspective discussing the STEM initiatives in the state of Iowa and ways these initiatives impact STEM education and careers. Although advances have been made to increase the number of females entering the STEM workforce, there remains a significant gap between men and women due to several factors. One factor is the confidence in math and science. The literature reviewed in the remaining subsections of this chapter explores girls’ interest and confidence in math and science. Additionally, possible predictors of middle school girls’ confidence and interest in math and science include teacher influences, parent encouragement, peer influences, and self-efficacy. Literature relating to each of the possible predictors is explored further in the following subsections.

#### Historical Perspective

In the early 1900s, STEM (Science, Technology, Engineering and Mathematics) education took place primarily in specialized schools for the gifted and talented students. However, the first specialized schools that were designed to meet the need of a technically trained workforce were created as early as 1922. Schools specifically designed for math and science studies were developed as early as 1938, but it was not until Sputnik in 1957 that

changed the face of STEM education. According to Thomas and Williams (2010), “Cold War anxieties provided the rationale for an increased emphasis in science and technology” (p.18).

The National Consortium for Specialized Secondary Schools of Mathematics, Science and Technology was formed in 1988 to change the delivery of STEM education to “enable students to meet the challenges of the future, namely, the shortage of students entering STEM majors and careers” (Thomas & Williams, 2010, p. 19). STEM education became a high priority in the United States when bipartisan legislation was enacted in August of 2007 to ensure that the United States was competitive in the global market in the areas of science, technology, engineering, and mathematics. This act, America COMPETES, focused on the following three crucial areas: “(a) increasing research investment; (b) strengthening educational opportunities in science, technology, engineering and mathematics from elementary through graduate school; and (c) developing an innovation infrastructure” (Thomas & Williams, 2010, p. 17). Because of our country’s growing demand in these career fields and little workforce to support that demand, this act became imperative and specialized STEM education was made a high priority.

### **Local Perspective**

In 2009, the Governor of Iowa began the Iowa Mathematics and Science Education Partnership to provide for and fund outreach projects, externships, and resources for educators (IMSEP, 2012). The goal of this group is to increase student achievement in math and science, improve teaching practices in math and science, and increase collaboration on STEM initiatives across the state through professional development and outreach programs.

In 2010, efforts to expand STEM education and initiatives were pursued and the Governor’s STEM Advisory Council was formed. The primary responsibility of this committee

is to “advise the Governor on ways to improve education, innovation and careers in science, technology, engineering and mathematics for the public and private sectors” (Iowa.gov, 2012).

### **Microsystems of Middle School Girls’ STEM Development**

According to Bronfenbrenner (2005), microsystems are described as the relationships between outside influences that impact the developing person. The microsystems in this study include teacher influences, parent encouragement, and peer influences. These microsystems will be specifically explored to determine to what extent they are predictors of middle school girls’ confidence and interest in both math and science. The review of literature explains the microsystems in relation to the STEM development of middle school girls.

### **Confidence in Math and Science**

One way to improve STEM education and initiatives is to increase the confidence of adolescent girls in math. Lupkowski-Shoplik & Piskurich (2011) report that girls in middle school exhibit a decrease in self-confidence and career aspirations. Girls believe that math content is too difficult and that they are not capable of learning the material. This may be due to the fact that this study shows girls internalize their failures, while boys find external factors to blame for failures (Lupkowski-Shoplik & Piskurich, 2011). According to Cann (2008), boys reported more often than girls that they were good at math. Girls interviewed reported that they worry about their work more and fear doing it wrong. This anxiety, Cann (2008) explains, is connected to girls’ personal development, which includes how girls are socialized during their childhood. According to Devine, Fawcett, Szucs, and Dowker (2012), females are less confident in math because math is viewed as a male domain, and girls are not as competent in math. Math performance in this study showed a significant difference between boys and girls and was related

to math anxiety which is higher in females. National assessments also show males perform at higher levels than females.

AAUW (2010) suggests that many young women in STEM majors do not feel like they belong, and low test scores can have an even more negative effect on the confidence of girls. In addition, Shapiro and Williams (2012) report girls who have low confidence in math also feel less confident about other STEM areas such as science. There are several factors that contribute to low confidence in girls in science. According to Heaverlo (2011), confidence in both science and math is significantly impacted by teacher influences. The findings in this study have implications for STEM education reform including the way classrooms are structured. Halpern (2007) suggests that girls' self-confidence can be influenced by explicitly teaching girls that their academic abilities are malleable and not fixed. Halpern further explains a number of ways that teachers can have an impact on the confidence of girls in math and science including the development of spatial skills. Strategies suggested by Halpern for teachers to use in order to increase confidence and interest and performance in math and science include:

- Provide girls with immediate feedback on performance.
- Show representation of female role models.
- Connect activities in math and science to careers without stereotypes.

AAWU (2010) also reports that the lack of spatial skills has an impact on girls' confidence in STEM subjects, and therefore, has an impact on their interest level.

### **Interest in Math and Science**

One way that has been suggested to improve STEM education and initiatives developed to promote STEM careers for girls is to increase the interest of adolescent girls in math.

According to the American Association of University Women (2010), "girls who believe that

intelligence can expand with experience and learning tend to do better on math tests; these girls are also more likely to say they want to continue to study math in the future” (p. 1). The AAUW (2010) also reports that parents and teachers can do a great deal to increase the interest of girls in the STEM subject areas. In the past, girls heard the message and stereotype that men have a natural propensity to math; however, recent gains in girls’ achievement in math are beginning to contradict this stereotype. Fisher, Dobbs-Oates, Doctoroff, and Arnold (2012) report no correlation between gender and interest in mathematics at the pre-school age. Therefore, it is imperative to look at the culture and learning environments of the K-12 environment to encourage the interest of girls. Even subtle innuendos that indicate boys are better at a certain subject area have shown a poor impact on girls’ math test achievement. Efforts to reverse these stereotypes, however, have shown to increase girls’ interest and performance in math (AAUW, 2010). Rowan-Kenyon, Swan, and Creager (2010) suggest teacher support, parent involvement, and peer behaviors are important factors that help or hinder interest in mathematics.

According to the Iowa Annual Condition of Education Report by the Iowa Department of Education (2011), 65.7% of students in Iowa enrolled in chemistry while only 26.5% enrolled in physics. In this analysis, 70.6% of all females took chemistry while 61% of all boys took chemistry. This information is important because it shows that STEM initiatives in Iowa related to education appear to be working at the high school level based on this snap shot data.

Although, academic achievement appears to be on the rise, girls’ interest in science is not without limitations. Weisgram and Bigler (2007) report that self-efficacy and utility value have a positive impact on girls’ interest in science. When girls are exposed to information about discrimination and stereotypes toward women in science, their interest in science increases. Additionally, according to Kreger, Martin and Bunner (2011) girls’ interest in science increases



when presenting information using what they term stereotypical feminine topics (Kreger, Martin, Bunner, 2011). These feminine topics include those that involve social situations or simulate real-life situations. Kreger, et al. also found that girls are more interested in practical applications of biology such as decline of forests and description of plants.

AAUW (2010) reports that how girls feel about math impacts their interest in pursuing science careers. Furthermore, both teachers and parents are important in encouraging girls' interest and achievement in science (AAUW, 2010).

Efforts to increase STEM education are happening at both federal and state levels. According to the National Academy of Sciences (2013), the National Research council created a committee to determine fourteen indicators used to monitor the success of STEM education. One of these indicators is the measurement of student interest and participation in STEM subjects such as math and science. The report further explains the goals at the national level which include:

- Increase the number of students receiving advanced and STEM degrees while also increasing the number of women and minorities in STEM programming.
- Increase the STEM workforce focusing on women and minorities.
- Increase STEM literacy efforts.

The efforts to attain these goals focus on the teacher influences in the classroom, which has been shown to be a predictor of girls' interest and confidence in math and science (Heaverlo, 2011).

### **Girls' Self-Efficacy**

When determining the confidence and interest an adolescent girl has in math and science, it is key to explore student self-efficacy as a possible predictor. Bandura (1986) explains self-

efficacy as a feeling of competence that impacts student interest and engagement in academic areas. Falco, Summers, and Bauman (2010), Falco, et al. (2010) further describes that “early adolescents tend to have lower perceptions of their competence than elementary school-aged children” (p.531). According to Falco et al. (2010), student self-beliefs are directly connected to the academic choices they make. Therefore, early intervention in self-efficacy awareness for middle school girls can be quite beneficial in making course decisions. In particular, girls’ self-efficacy decreases during this time especially in the subject area of mathematics (Falco et al., 2010). According to Akin and Kurbanoglu (2011), there is a negative relationship between math anxiety and self-efficacy. Akin and Kurbanoglu also report that self-efficacy predicted a positive impact on positive attitudes and a negative impact on negative attitudes. Therefore, it is critical that girls in math and science begin with a strong sense on self-efficacy toward these subjects.

Stevens, Wang, Ovivarez Jr., and Hamman (2007) report a direct relationship between self-efficacy and mathematics enrollment plans. Their study also found that mathematics self-efficacy may be lower in middle school due to the increase in abstract reasoning and spatial skills required to complete math tasks. Therefore, the lack of self-efficacy would directly impact the enrollment intentions and overall interest in math.

Gibbons and Boarders (2011) suggest that college preparation programs begin in middle school due to self-efficacy implications. Along with college preparation programs, intervention programs should also be introduced and focus on perceptions of women in STEM careers. These intervention programs prove to be most effective prior to the eighth grade (Cho, Goodman, Oppenheimer, Codling, & Robinson, 2009).

### **Teacher Influences**

Teachers can underestimate the impact they have on the interest and confidence of the students in the classroom. However, research indicates that teacher influences is a significant predictor of student interest and confidence in STEM education (Heaverlo, 2011; AAUW 2012; Rowan-Kenyon, Swan, & Creager, 2010). According to Little and Leon de la Barra (2009), many studies suggest that girls and boys interests in STEM areas are different. Girls prefer the areas of study that help people and deal with the earth and animals while boys are interested in physics and technology. Teachers can have a large impact in cultivating these interests.

McCarthy and Slater (2011) suggest that teachers create a culture of openness and inclusion. The language of the teacher should be equitable eliminating phrases such as “you guys.” Teachers must challenge students to help create learning experiences that focus on research, design, creating solutions, and evaluating products. Instructors need to abolish feelings of competition and cultivate a culture of working together in teams to create and innovate. Providing choices for students while focusing instruction on the human needs connection to help people in real situations will spark the interest in the female student (McCarthy & Slater, 2011).

According to AAUW (2010), there are many things teachers can do to promote the success of girls in math and science. Some of which include the following:

- Provide successful female role models.
- Teach girls the growth of intellectual skills such as math.
- Develop girls’ spatial skills.
- Encourage girls to take higher level math and science courses.
- Reduce stereotypes and make expectations clear.

Some additional methods in which teachers can have an impact on girls' interest and confidence in STEM areas such as math and science include encouraging STEM career exploration at an early age, providing for more hands-on approaches in delivering course content, bringing in female role models for STEM presentations, and making sure that there are female role models in classroom materials posted on the walls (Heaverlo, 2011).

The key to creating better STEM education is to increase scientific literacy of our teachings and making appropriate materials and teaching tools readily available for instruction (Little & Leon de la Barra, 2009; Rowan-Kenyon, Swan, & Creager, 2010).

### **Parent Encouragement**

The American Society for Quality (2012) conducted a national survey that indicated 21% of parents of girls between the ages of 8-17 encouraged their children to become actresses while only 10% of parents encouraged their adolescent girls to become engineers. On the other hand, 31% of boys were encouraged by their parents to think about becoming an engineer. Rowan-Kenyon, Swan, & Creager (2010), report several responses from girls that parents help them with their math homework and expect them to get good grades. This support and high expectations from parents of their female children are critical to the success and retention of girls in math as they grow older. Teachers also indicate that parent encouragement and support is a powerful indicator of math success (Rowan-Kenyon, et al., 2010).

In addition, parent's actions significantly impact the perceptions of girls and boys. According to Lupkowski-Shoplik & Piskurich (2011), parents are more likely to purchase a computer for their son rather than their daughter. Campbell's (1991) suggestions of ways in which parents can encourage girls to pursue a STEM career include:

- Stress the importance of math and science in seventh and eighth grade.

- Include math and science a part of everyday life.
- Watch words and actions that perpetuate stereotypes.
- Focus on career exposure.
- Be aware of the misinformation about women in STEM careers.
- Be involved in the child's classroom.
- Help girls get over the “nerdy” image of math and science.

AAUW (2010) suggests that parents can encourage their girls' interest and performance in math and science by eliminating stereotypes that boys are typically good at math and science and by encouraging their girls to pursue careers in STEM areas. Parents can also expose their girls to female role models in math and science related careers (AAUW 2010).

### **Peer Influences**

Relationships between adolescent peers are a significant factor in connectivity to school according to Lizzo, Dempster and Neumann (2011). Therefore, it is no surprise that girls are influenced by their peers in course selection. According to the Williams Project on the Study of Economics in Higher Education (2012), students who are strong academically have a positive impact on their peer group. Liem and Martin (2011) explored the impact of same gender and opposite gender peer relationships of a number of school related variables. In their study, they found that same gender peer relationships significantly predicted academic performance and that same gender peer relationships have a more positive influence on school engagement. The study also finds that both same gender and opposite gender peer relationships impact general self-esteem which impacts confidence levels.

According to Nelson and DeBacker (2008), there is a direct connection between motivation to learn and social environments. In addition, Nelson & DeBacker found peer

climate variables predicted both performance goals and self-efficacy. Therefore, when peer climate is positive toward math then students will perform better on math tasks and self-efficacy in math is positive. The opposite holds true if the peer climate is negative. Hanushek, Kain, Markman, and Rivkin (1999) also report a positive correlation between math achievements in general to the average achievement of peers.

### **Macrosystems of Middle School Girls' STEM Development**

According to Bronfenbrenner (2005), macrosystems encompass “the overarching patterns of stability, at the level of the subculture or the culture as a whole, in forms of social organization and associated belief systems and lifestyles” (p. 47). In this study, the macrosystem is comprised of race/ethnicity, age, and gender, which remains constant.

### **Race/Ethnicity**

The research indicates that minority women are significantly underrepresented in STEM careers. Of the 14% of the engineers who are women, only 12% to 16% are African-American or Latino women (Koebler, 2011). Currently, African American and Latino populations account for 30% of the population in the United States. According to the United States Department of Commerce's 2011 report on racial and ethnicity equality in STEM, there must be an increase in STEM education for underrepresented groups. The findings in this report include:

- Approximately seven out of ten STEM workers are white/non-Hispanic.
- Asians are 42% more likely to graduate with a STEM degree.
- Of the Asian population with STEM degrees, half have STEM jobs.
- Only 30% of the Hispanic, Black, and Indian American population with STEM degrees have a STEM job.
- One in five STEM workers is born in another country.

This report by the United States Department of Commerce (2011) indicates that the reason there are less Black and Hispanic people in STEM careers is the low college graduation rate of these underrepresented populations. Recent research also shows promising results that girls' race/ethnicity does not significantly impact their confidence and interest in math and science (Haeverylo, 2010). Museus, Palmer, Davis, and Maramba (2011) report that there are several factors from a k-12 education perspective that plays a role in minorities being underrepresented in STEM programs which include:

- Lack of funding in public schools.
- Unqualified teachers serving in schools with high minority populations.
- Limited opportunities for Advanced Placement.
- Low teacher expectations of minority students.
- Stereotypes of minority student's academic performance.
- Minority drop-out rate.
- Oppressive culture.

With all of these barriers for minority students, Museus et al. (2011), finds that there is much to be done in order to increase the likelihood of minorities pursuing a STEM career. Parental involvement and support is a key part of encouraging minority students' confidence and interest. In addition, providing bilingual education, exposing students to STEM curriculum and opportunities, and focusing on self-efficacy can increase confidence and interest (Museus et al., 2011).

### **Age**

Age is appropriate to consider as students determine their career path at such a young age. According to Gibbons and Boarders (2011), students are making decisions about their

careers between 8<sup>th</sup> and 10<sup>th</sup> grade. Therefore, beginning STEM education at a young age is critical. According to the STEM Summit report (2010), early math skill acquisition is a strong predictor of later academic achievement. The report also explains that children who have difficulties in math are less likely to graduate or attend college. Therefore, it is important to begin preparing children for early math and science prior to kindergarten. The STEM Summit report (2010) explains that children need planned activities and explicit instruction around math and science topics. The concept of play is significant when teaching younger students math and science (STEM Summit report, 2010).

Secondary education should focus on problem solving while promoting self-confidence and creativity (STEM Summit report, 2010). The report further indicates the need for engagement and exploration in k-12 programming. When students become confident in math and science at an early age, they are more likely to be interested in a STEM career as they grow older. A report from the Girl Scout Research Institute (2012) found:

- Adolescent girls who were interested in STEM were slightly more interested in problem solving than their peers who were not interested in STEM.
- Girls want to help make a difference for people.
- Girls interested in STEM areas have supportive adults in their lives.
- Perceived gender barriers are still a reason why girls don't pursue STEM careers.

The Girl Scout Research Institute (2012) also reports that middle school girls begin to lose their confidence and interest in math and science due to stereotypes. Middle school is the pivotal point to capture the confidence and interest in math and science.



### **Summary**

The review of the literature supports the hypothesized relationships between factors influencing girls' confidence and interest in math and science. These factors include self-efficacy, teacher influences, parent encouragement, and peer influences. Each of these variables was supported in the literature as possible predictors for middle school girls' confidence and interest in math and science. Additionally, this chapter explored the current conditions of education in Iowa for girls in terms of STEM education.

## CHAPTER 3

### METHODOLOGY

*“We need to move the needle – immediately and sustainably – on student performance in critical STEM areas.”*

*-Rex Tillerson, Chairman and CEO of ExxonMobil*

The purpose of this study is to identify the predictors that influence middle school girls' confidence and interest in math and science by analyzing data collected from middle school girls in 6<sup>th</sup> and 7<sup>th</sup> grade. This chapter provides the research design of the study which includes a statement of the research questions, and an explanation of the research design, methodological approach, setting, population/sample, data collection, instrumentation, variables, and data analysis. Conclusively, this chapter will describe the limitations and delimitations of the study.

#### Research Design

This study was a quantitative research study using a correlational/survey methodology where the independent variables are not manipulated. Additionally, the study was grounded in the post-positivism theoretical perspective. According to Crotty (1998), the theory suggests that the observed and the observer have a strong relationship and depend upon one another. Post-positivists believe in the method, but agree that there may be issues within the research (Crotty, 1998). The premise is to attempt to prove a theory wrong rather than to prove the theory right. Because of those issues in the research, Crotty (1998) further explains that the research process lends credibility to the study. Ultimately, post-positivism seeks to gain a better understanding of what could be happening in a specific situation.

Phillips and Burbles (2000) focus on five key assumptions to gain a better understanding of the post-positivist perspective.

1. Evidence in research is never absolute or perfect.

2. Research begins testing a theory. The claims made are tested and replaced with claims that prove stronger.
3. Information is collected by the researcher on participants using specific measurable data.
4. Researchers seek to understand the relationships among variables to pose a hypothesis or ask questions.
5. Researchers must be objective in examining methods and conclusions.

### **Methodological Approach**

This study employed a survey research methodological approach. According to Floyd and Fowler (2009), “surveys are designed to produce statistics about a target population” (p. 11). The purpose of using survey research is to gather quantitative data through questioning people. Fowler (2009) suggests that this information is taken from a portion of the target population rather than every member of the population. The primary objective of survey methodology is to minimize and measure error in the research. With that in mind, Fowler (2009) explains that a good sample survey combines three methodologies including sampling, designing questions, and data collection.

When examining sampling, Fowler (2009) suggests focusing on the following:

- The decision to use a probability sample
- Who will be included in the sample
- The size of the sample
- The design of the sample
- The accuracy of the data collected

When considering the design of the questions, Fowler (2009) explains the importance of using previous literature to determine validity and reliability of the questions, whether or not to utilize outside resources, and if pre-testing is required. After designing the questions, Fowler (2009) describes the significance of how the data are collected. The mode of collection can have an impact on the quality of the data. When all three are thoroughly examined, a survey becomes more reliable.

Fowler (2009) describes the issues that still remain after taking the necessary precautions. One issue is the uncertainty of how the sample responds as a representation or generalization of the entire population. Yet another issue arises with the uncertainty of how well the answers to the questions measure the characteristics described. The responses from the survey questions in this study will provide insight to the overall research questions.

The goal of this study is to collect information from 6<sup>th</sup> and 7<sup>th</sup> grade students to determine predictors of girl's confidence and interest in STEM subject areas such as math and science; therefore, survey methodology is appropriate for this study.

This study focuses on the following research questions:

1. What are the demographics of the middle school girls who participated in this research?
2. Is there a statistically significant difference between middle school girls' a) confidence in math and interest in math, and b) confidence in science and interest in science?
3. To what extent do age, race/ethnicity, self-efficacy, parental encouragement, peer influence, and math teacher influence predict middle school girls' (6-7<sup>th</sup> grade) interest in math?

4. To what extent do age, race/ethnicity, self-efficacy, parental encouragement, peer influence, and science teacher influence predict middle school girls' (6-7<sup>th</sup> grade) interest in science?
5. To what extent do age, race/ethnicity, self-efficacy, parental encouragement, peer influence, and math teacher predict middle school girls' (6-7<sup>th</sup> grade) confidence in math?
6. To what extent do age, race/ethnicity, self-efficacy, parental encouragement, peer influence, and science teacher predict middle school girls' (6-7<sup>th</sup> grade) confidence in science?

### **Participants**

Participants in this study were 225 middle school girls in grades 6<sup>th</sup> and 7<sup>th</sup>. Participants' ages ranged from 11-13. Participants attended a school district in Iowa that has an approximate enrollment of 9,000 students with a graduation rate of over 90%. Approximately 90% of seniors intend to pursue post-secondary education. This suburban area is comprised of a predominately Caucasian and a higher socio economic status population.

### **Data Collection**

The paper/pencil survey was distributed during advisory group that takes place the last 20 minutes before school is dismissed. The 42 question survey instrument was developed using existing surveys that measure student confidence and efficacy, parental encouragement, peer encouragement, and teacher influences. The survey was pilot tested in May of 2012. Fifty-five students completed the pilot test and the average time to take the survey was approximately 10 minutes.

Approval for this study was granted through the Drake Institutional Review Board for Human Subjects Research. Consent forms (See Appendix A) and assent forms (See Appendix B) were distributed and completed one week prior to the completion of the survey.

### **Survey Instrument**

The survey (see Appendix C) developed in this study was designed to measure the interest and confidence of middle school girls in math and science, level of self-efficacy, impact of teacher influences, level of parent encouragement, and impact of peer influences. The survey instrument is comprised of several questions taken from the survey developed by Heaverlo (2011). Of these 42 questions, 13 questions focus specifically on the confidence and interest of girls in math and science subjects. Examples of the questions on the survey include:

- I look forward to coming to class because of my interest in this subject.
- I enjoy learning the material in this class.
- I am confident that I can learn this subject.

In addition, 11 questions address the influences of math and science teachers.

Examples of the questions on the survey include:

- My teacher encourages us to ask questions.
- My teacher asks questions that challenge me to think.
- I get helpful feedback from my teacher.

There are 4 questions that address parent encouragement. A few of survey questions include:

- My parents/guardians discuss selecting courses with me frequently.
- My parents/guardians often check on my homework.
- My parents encourage me to take higher level math courses.

There are 6 questions that address peer influences. A few of the survey questions include:

- My friends encourage me to take more or higher level math courses.
- My friends like math.
- My friends do well in science.

There are also 5 questions focusing on self-efficacy. A sample of the survey questions include:

- I can express my opinions when other classmates disagree with me.
- I can succeed in understanding all subjects in school.
- I set high expectations for myself.

Finally, there are 5 questions addressing demographics such as age, grade, gender, race, and future occupation preferences.

The dependent variable questions of confidence and interest from this survey are measured on a Likert-type scale with 1= strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = strongly agree. The independent variable questions of teacher influences, self-efficacy, parent encouragement, and peer influences from this survey are also measured on a Likert-type scale with 1= strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, and 5 = strongly agree. Finally, the last section of the survey is dedicated to the demographic information and possible career choice in the future.

### **Variables**

Through response to the survey questions, this study examined possible predictors of middle school girls' confidence and interest in math and science classes. As the possible predictors are explored, Bronfenbrenner's model will guide the methodological approach. The

independent variables include teacher influence, parental encouragement, peer influence and student efficacy. The dependent variables for this study include math confidence, math interest, science confidence, and science interest. For each of the dependent and independent variables, a factor analysis was conducted.

Tabachnick and Fidell describe factor analysis as a statistical technique applied to a single set of variables when the researcher is interested in discovering which variables in the set form coherent subsets that are relatively independent of one another. This process is useful for purposes of finding correlations and patterns among variables as to not test each variable independently but instead consist of “several factors that represent the area to be measured (Tabachnick & Fidell, 2007, p. 607).

Tabachnick and Fidell (2007) further explain that the “validity of the factors is tested in research where predictions are made regarding differences in the behavior of persons who score high or low on a factor” (p. 607).

Table 3.1

*Connections to Theoretical Framework and Review of Measurement Variables*

<b>System</b>	<b>Variable</b>	<b>Type</b>	<b>Description (measured by)</b>
Macro	Gender	Constant	Not measured – held constant
Macro	Race/Ethnicity	IV	Recoded to a dichotomous variable: 0 = minority; 1 = non-minority
Macro	Age	IV	Continuous variable
Micro	Student efficacy	IV	Factored construct
Micro	Teacher Influences	IV	Factored construct
Micro	Parent Encouragement	IV	Factored construct
Micro	Peer Influence	IV	Factored construct
Micro	Math Confidence	DV	Factored construct
Micro	Science Confidence	DV	Factored construct
Micro	Math Interest	DV	Factored construct
Micro	Science Interest	DV	Factored construct



## Independent Variables

According to Tabachnick and Fidell (2007), independent variables “are the differing conditions to which you expose your subjects, or characteristics that the subjects themselves bring in to the research situation” (p. 2). In a regression analysis, the independent variable predicts the dependent variable and may change based on research context. In this study, the independent variables included teacher influence, parent encouragement, peer influence, and self-efficacy.

**Math Teacher Influence.** Green and Salkind (2011) explain factor analysis as “a technique used to identify factors that statistically explain the variation and covariation among measures” (p. 313). According to Green and Salkind (2011), the two parts of factor analysis are factor extraction and factor rotation. Factor extraction is used to determine the number of factors that are a part of a set of measures. The factor rotation is used to make the factors more meaningful. In other words, they align the best. Using the varimax approach is the most popular way to rotate the factors because they are easier to summarize. Through a factor analysis of the 11 questions measuring a math teacher’s influence on students in the classroom, a factored variable was created from 6 of the questions that aligned to reflect the impact of a teacher on a student’s interest in math (eigenvalue = 4.620, variance explained = 42%). The Kaiser’s measure of sampling adequacy (KMO) for the entire construct was .872. Higher scores on this factored variable indicate greater teacher influence on the student. Table 3.2 provides a list of the items that were factored along with the factor loadings for each item and the alpha coefficient for the new factor.

Table 3.2

*Factor Analysis for Math Teacher Influences*

Item	Factor Loadings
Math Teacher Influences ( $\alpha = .834$ )	
My teacher creates a classroom environment that allows me to learn	.797
I am comfortable asking my teacher questions about math	.774
I get helpful feedback from my math teacher	.749
My teacher encourages my responsibility and effort	.680
In class, we use a variety of classroom activities and resources to help me learn this subject	.558
My math teacher encourages us to ask questions	.473

**Science Teacher Influence.** Through a factor analysis of the 11 questions measuring a science teacher's influence on students in the classroom, a factored variable was created from 7 of the questions that aligned to reflect the impact of a teacher on a student's interest in math (eigenvalue = 4.337, variance explained = 39%). The Kaiser's measure of sampling adequacy (KMO) for the entire construct was .876. Higher scores on this factored variable indicate greater teacher influence on the student. Table 3.3 provides a list of the items that were factored along with the factor loadings for each item and the alpha coefficient for the new factor.

Table 3.3

*Factor Analysis for Science Teacher Influences*

Item	Factor Loadings
Science Teacher Influences ( $\alpha = .780$ )	
My teacher encourages us to apply what we've learned to situations outside of class	.689
My teacher talks about possible careers that related to this subject	.681
My teacher tells the class about resources that will help us learn this subject	.633
My teacher asks questions that challenge me to think	.632
My teacher encourages us to ask questions	.563
My teacher communicates high expectations	.492
I get helpful feedback from my teacher	.467

**Parent Encouragement.** Also through factor analysis of the four survey questions regarding the impact of parents' encouragement on their children, a parent encouragement factored variable was created (eigenvalue = 2.725, variance explained = 68%). The Kaiser's measure of sampling adequacy (KMO) for the entire construct was .799. Higher scores on this factored variable indicate greater parent encouragement on the student. Table 3.4 provides a list of the items that were factored along with the factor loadings for each item and the alpha coefficient for the new factor.

Table 3.4

*Factor Analysis for Parent Encouragement*

Item	Factor Loadings
Parent Encouragement ( $\alpha = .799$ )	
My parents/guardians discuss selecting math and science courses with me	.880
My parents/guardians encourage me to take more math or science courses	.844
My parents/guardians discuss things I have studied in math or science class	.802
My parents/guardians talk to me about future careers that involve my learning math or science	.771

**Math Peer Influences.** This variable was derived from a factor analysis of three separate survey questions regarding the impact of peers on student course choices in math (eigenvalue = 1.768, variance explained = 59%). The Kaiser's measure of sampling adequacy (KMO) for the entire construct was .598. Table 3.5 provides a list of items that were factored along with the factor loadings for each item and the alpha coefficient for the new factor.

Table 3.5

*Factor Analysis for Peer Influences in Math*

Item	Factor Loadings
Peer Influences ( $\alpha = .625$ )	
My friends like math	.845
My friends do well in math	.795
My friends encourage me to take more or higher level of math courses	.649

**Science Peer Influences.** This variable was derived from a factor analysis of three separate survey questions regarding the impact of peers on student course choices in science

(eigenvalue = 1.766, variance explained = 59%). The Kaiser's measure of sampling adequacy (KMO) for the entire construct was .584. Table 3.5 provides a list of items that were factored along with the factor loadings for each item and the alpha coefficient for the new factor.

Table 3.6

*Factor Analysis for Peer Influences in Science*

Item	Factor Loadings
Peer Influences ( $\alpha = .614$ )	
My friends like science	.845
My friends do well in science	.841
My friends encourage me to take more or higher level science courses	.588

**Self-Efficacy.** This variable was also determined by factor analysis of four survey questions measuring overall efficacy of students (eigenvalue = 1.908, variance explained = 48%). The Kaiser's measure of sampling adequacy (KMO) for the entire construct was .646. Table 3.7 provides a list of the items that were factored along with the factor loadings for each item and the alpha coefficient for the new factor.

Table 3.7

*Factor Analysis for Self-Efficacy*

Item	Factor Loadings
Self-Efficacy ( $\alpha = .624$ )	
I can express my opinions when other classmates disagree with me	.765
I set high expectations for myself	.691
I can succeed in understanding all subjects in school	.687
I can tell my classmates of friends that they are doing something that I don't like	.610

## Dependent Variables

Tabachnick and Fidell (2007) describe the dependent variable as “the response or outcome variable” (p. 2). These variables are also known as criterion variables and whose outcome may or may not be influenced by the independent variable. In this study, the dependent variables include math confidence, math interest, science confidence, and science interest.

**Confidence in Math.** A factor analysis was conducted on each of these dependent variables using the six survey items that relate to confidence in math (eigenvalue = 3.035, variance explained = 51%). The Kaiser’s measure of sampling adequacy (KMO) for the entire construct was .839. Table 3.8 lists the items entered into the factor analysis along with the factor loadings for each item and the alpha coefficient for the new factor.

Table 3.8

### *Factor Analysis for Math Confidence*

Item	Factor Loadings
Confidence in Math ( $\alpha = .789$ )	
I am confident that I can learn this subject	.829
I am successful in understanding all the material in this class	.802
When I get stuck on a question, I can usually get it	.779
I am comfortable seeking help when I have questions about this subject	.677
Studying this subject makes me feel nervous/anxious	.605
I can succeed in finishing all my homework for this class every day	.522

**Confidence in Science.** A factor analysis was conducted on each of these dependent variables using the five survey items that relate to confidence in science (eigenvalue = 2.855,

variance explained = 48%). The Kaiser's measure of sampling adequacy (KMO) for the entire construct was .804. Table 3.9 lists the items entered into the factor analysis along with the factor loadings for each item and the alpha coefficient for the new factor.

Table 3.9

*Factor Analysis for Science Confidence*

Item	Factor Loadings
Confidence in Science ( $\alpha = .788$ )	
I am confident that I can learn this subject	.841
I am successful in understanding all the material in this class	.820
When I get stuck on a question, I can usually get it	.731
I am comfortable seeking help when I have questions about this subject	.687
I can succeed in finishing all my homework for this class every day	.553

**Interest in Math.** A factor analysis was again conducted for these variables using the six survey items that relate to interest in math and (eigenvalue = 3.713, variance explained = 62%). The Kaiser's measure of sampling adequacy (KMO) for the entire construct was .843. Table 3.10 provides a list of the items that were factored along with the factor loadings for each item and the alpha coefficient for the new factor.

Table 3.10

*Factor Analysis for Math Interest*

Item	Factor Loadings
Interest in Math ( $\alpha = .869$ )	
I look forward to coming to class because of my Interest in this subject	.889
I enjoy learning the material in this class	.835
I am happier in this class than any other class	.805
I look for ways to learn more about this subject	.759
I plan to take as many classes in this subject as possible	.748
I look for or participate in activities related to this subject	.664

**Interest in Science.** A factor analysis was again conducted for these variables using the six survey items that relate to interest in science (eigenvalue = 3.801, variance explained = 63%). The Kaiser's measure of sampling adequacy (KMO) for the entire construct was .869. Table 3.11 provides a list of the items that were factored along with the factor loadings for each item and the alpha coefficient for the new factor.

Table 3.11

*Factor Analysis for Science Interest*

Item	Factor Loadings
Interest in Math ( $\alpha = .869$ )	
I enjoy learning the material in this class	.859
I look forward to coming to class because of my Interest in this subject	.859
I am happier in this class than any other class	.778
I plan to take as many classes in this subject as possible	.788
I look for ways to learn more about this subject	.790
I look for or participate in activities related to this subject	.716



## **Data Analysis**

Prior to data analysis, it is important to check for any missing data, and that the data meet the assumptions for normality required for inferential statistical analysis such as independent samples t-tests and hierarchical regression. According to Green and Salkind (2011), the assumptions that must be met are that the “test variables are normally distributed in the population” and that “participants included in the study are taken from a random sample and the scores on the test variable are independent of each other” (p. 164).

### **Descriptive Statistical Analysis**

Tabachnick and Fidell (2007) explain “descriptive statistics describes samples of subjects in terms of variables or combinations of variables” (p. 7). Descriptive statistical analysis in this study reported means, standard deviations, and frequencies on demographic data, dependent variables and independent variables. Research question 1 was answered using descriptive statistical analysis.

### **Inferential Statistical Analysis**

Tabachnick and Fidell (2007) describe inferential statistical analysis as “techniques that test hypotheses about differences in populations on the basis of measurements made on samples of subjects” (p. 7). Inferential analysis conducted in this study include the Pearson correlation, paired samples t-test, and hierarchical regressions.

**Correlations.** According to Green and Salkind (2011), “the Pearson product-moment correlation coefficient ( $r$ ) assesses the degree that quantitative variables are linearly related in a sample” (p. 257). In other words, this correlation determines if there is a relationship between the variables in the sample. Green and Salkind (2011) further discuss the two assumptions essential to the significance test of the Pearson correlation coefficient. The first assumption

suggests that the variables are bivariately normally distributed. This means that each of the variables is normally distributed independently and at all levels. If the assumption does not hold true, there may be a nonlinear relationship that exists. Green and Salkind further describe the second assumption which requires that “the cases represent a random sample from the population and the scores on variables for one case are independent of scores on these variables for other cases” (p. 258). If this assumption does not hold true, there is no need to run a significance test. Finally, the Pearson correlation coefficient is reported as an effect size ranging from -1 to + 1, which is represented in a correlation matrix with all of the variables. Since several correlations were computed in this study, a Bonferroni approach was used to control for Type 1 errors. Green and Salkind (2011) describes the Bonferroni approach “requires dividing .05 by the number of computed correlations” (p. 261). A correlation would only be significant if the *p*-value is less than the adjusted significance.

**Paired samples *t*-test.** Green and Salkind (2011) explain that paired samples *t*-test is used to “evaluate whether the mean of the difference between the two variables is significantly different from zero” (p. 169). In this study, the difference between middle school girls’ confidence and interest in math were explored. Additionally, this study examined the difference between middle school girls’ confidence and interest in science. Two paired samples *t*-tests were be conducted:

- confidence in math as compared to interest in math
- confidence in science as compared to interest in science

### **Sequential Multiple Regression**

In sequential multiple regression, Tabachnick and Fidell (2007) explain that “IVs enter the equation in an order specified by the researcher” (p. 138). The IV most valued based on

theoretical consideration is placed in the first block, and those given priority next are placed in the second block. The relationship between the IVs and DVs is re-assessed each time a new set of IVs is added in order to determine a reduced set of IVs that add to the predictability. The following equation represents a multiple regression:

$$Y = A + B_1X_1 + B_2X_2 + \dots + B_kX_k$$

In this equation, Y represents the dependent variable while the X values represent each of the independent variables. The key to the sequential regression is the change in  $R^2$  value as the IV blocks are added. According to Tabachnick and Fidell (2011), the null hypothesis is proven if there is no change in the  $R^2$  when a new block of IVs are added. When the new block of IVs added significantly increases the  $R^2$ , the null hypothesis is rejected.

In this study, questions 3 through 6 were answered using sequential hierarchical regression analysis. In block 1, the variables self-efficacy, ethnicity/race and age will serve as the predictors. In block 2, the external factors such as teacher influences, parent encouragement and peer influences serve as predictors.

**Regression model for math confidence.** This model will be run using math confidence as the dependent variable. First, a factor analysis was conducted to create a construct for the math confidence dependent variable. A factor analysis was also conducted for teacher influences, parent encouragement, peer influences, and student efficacy. According to Green and Salkind (2011), “factor analysis is a technique used to identify factors that statistically explain the variation and covariation among measures” (p. 313). This means that there is a linear

relationship between the variables and that they are normally distributed. Using this technique computes several variables into one independent variable.

After factor analysis, a regression was run on those factors to indicate possible predictors of math confidence of middle school girls'. Block 1 consisted of the self-efficacy, race, and age; while block 2 consisted of the microsystems teacher influences, parent encouragement, and peer influences.

**Regression model for science confidence.** This model will be run using science confidence as the dependent variable. First, a factor analysis was conducted to create a construct for science confidence. A factor analysis was then conducted for teacher influences, parent encouragement, peer influences, and student efficacy. After factor analysis, a regression was run on the factors to indicate possible predictors of science confidence of middle school girls. Block 1 consisted of the self-efficacy, race, and age while block 2 consisted of the microsystems teacher influences, parent encouragement, and peer influences.

**Regression model for math interest.** This model was run using math interest as the dependent variable. First, a factor analysis was conducted to create a construct for math interest. A factor analysis was then be conducted for teacher influences, parent encouragement, peer influences, and student efficacy. After factor analysis, a regression was run on the factors to indicate possible predictors of math interest of middle school girls. Block 1 consisted of the self-efficacy, race, and age; while block 2 consisted of the microsystems teacher influences, parent encouragement, and peer influences.

**Regression model for science interest.** This model was run using science interest as the dependent variable. First, a factor analysis was conducted to create a construct for science interest. A factor analysis was then conducted for teacher influences, parent encouragement,

peer influences, and student efficacy. After factor analysis, a regression was run on the factors to indicate possible predictors of science interest of middle school girls. Block 1 consisted of the self-efficacy, race, and age while block 2 consisted of the microsystems teacher influences, parent encouragement, and peer influences.

### **Delimitations**

This study is delimited to female students in grades 6<sup>th</sup> and 7<sup>th</sup> at two suburban middle schools in the same school district in a Midwestern State.

### **Limitations**

This study focused on a limited population sample in a suburb of a Midwestern state which has a low poverty rate at 8.6% as compared to the state with 16%, a low minority population, and high academic achievement thus results may not be generalized to all 6<sup>th</sup> and 7<sup>th</sup> grade girls. Future research should be expanded to rural and urban populations. Additionally, research could be expanded to include grades 8<sup>th</sup> through 9<sup>th</sup> grade to gather comparative data throughout the middle school years.

Another limitation is the cross-sectional design of the study such that data are only collected at one point in time and interest and confidence may vary during a girl's academic development.

### **Summary**

In this chapter, the methodological approach was explained in depth. The research questions and design were addressed including specifics about the independent variables and dependent variables. In addition, each data analysis process was explained significantly and connected to a research question. Finally, the delimitations and limitations were discussed to provide opportunities for future research.

## CHAPTER 4

### RESULTS

*“We need to stop telling young women how hard it is to be a woman scientist and start telling them about how amazing the job is.” Professor Judith Mank (UCL).*

The purpose of this study was to explore potential predictors that influence middle school girls’ interests and confidence in math and science. Bronfenbrenner’s Bioecological model provided a conceptual framework from which to ground the previous literature and identify the possible predictors that influence middle school girl’s confidence and interest in math and science.

Chapter 4 reports the results of the data analysis and answers each of the six questions addressed in this study.

#### **Data Cleaning and Assumptions of Normality**

In order to ensure that there were no missing or incorrect values entered, data cleaning was conducted. This allowed for corrections to be made prior to conducting further tests. In addition, normality testing was conducted in order to assure that all assumptions of the Pearson correlation coefficient, paired samples *t*-test and the multiple regression analyses were met. Table 4.1 presents the data analysis for assessing normality. When a sample is normally distributed, “the values of skewness and kurtosis are zero” (Tabachnick & Fidell, p. 79). When a variable is skewed, according to Tabachnick & Fidell (2007), it is not in the center of the distribution but rather to the right (negative) or left (positive). The kurtosis has to do with the peak of the distribution of the sample. If the sample is not normal, there is an underestimation of the variance of the variable. Tabachnick & Fidell describes a positive kurtosis producing a tall, skinny distribution and a negative kurtosis as producing a short distribution that curves upward

on the outside. Normality analysis shows that all variables fell within acceptable ranges for skew and kurtosis (Tabachnick & Fidell, 2007).

Table 4.1

*Assessment of Normality for Variables (n = 225)*

Variables	Skew	SE of Skew	Kurtosis	SE of Kurtosis
Ethnicity/Race	1.194	.162	1.68	.323
Age	-.377	.162	-.718	.323
Self-Efficacy	-.445	.162	-.252	.323
Math Teacher Influence	-1.37	.162	2.26	.323
Science Teacher Influence	-.915	.162	1.01	.323
Parent Encouragement	-.415	.162	-.616	.323
Peer Influence – Math	.146	.162	-.444	.323
Peer Influence – Science	.096	.162	-.378	.323
Math Confidence*	-.799	.162	.393	.323
Science Confidence*	-.938	.162	.550	.323
Math Interest*	-.203	.162	-.576	.323
Science Interest*	-.182	.162	-.463	.323

\*Dependent Variable

### **Frequencies and Descriptive Statistic Analysis**

Descriptive and frequency analyses were conducted for all variables. Table 4.2 indicates the frequency distribution of the participants' ages and race/ethnicity. This table shows that approximately half (49.3%) of the participants were 12 years old. Participants that were 13 years old comprised 40% of the total, and 10.7% of the participants were 11 years old. The majority of the students participating in this study identified as white (84.4%) with only 15.6% of the participants identifying their race/ethnicity as a category other than white.

Table 4.2

*Frequency Distribution of Participants' Age and Race/Ethnicity (n = 225)*

Variable	N	%
Age		
11	24	10.7%
12	111	49.3%
13	90	40.0%
Race/Ethnicity		
White	190	84.4%
Non-white	35	15.6%

Table 4.3 reports descriptives for each of the variables including the minimum and maximum values, the mean and the standard deviation. As indicated in Table 4.2, there were 225 participants between the ages of 11 and 13 and participants identified as predominately white.



Table 4.3

*Descriptive Statistics for Demographic Data, IV, and DV Variables (n = 225)*

Variables	Min	Max	Mean	SD
Age	11	13	12.29	.650
Ethnicity/Race <sup>a</sup>	0	1	.16	.363
Self-Efficacy	8	20	16.31	2.56
Math Teacher Influence	6	30	25.79	4.21
Science Teacher Influence	10	35	27.83	4.74
Parent Encouragement	4	20	14.30	4.12
Peer Influence Math	3	15	9.60	2.62
Peer Influence Science	3	15	9.56	2.55
Math Confidence	9	30	24.60	4.13
Science Confidence	8	25	20.40	3.62
Math Interest	6	30	19.75	5.61
Science Interest	6	30	19.59	5.54

<sup>a</sup>Scale: 0=White 1=Non-white

### Correlations

After frequency and descriptive analysis were conducted, a Pearson correlation coefficient analysis was run on all variables to ensure that multicollinearity does not exist. Multicollinearity exists when the variables are so closely related that they seem to be measuring the same item, which is indicated by a correlation of .90 or greater (Tabachnick & Fidell, 2007). According to Green & Salkind (2011), the correlation coefficient reports an effect size ranging from -1 to +1. This score determines the strength of the relationship between the two variables.

In this study, correlation coefficients were computed among the 12 dependent and independent variables. Using the Bonferroni approach to control for Type I error across the 24

correlations, a  $p$  value of less than .001 ( $.05/66 = .001$ ) was required for significance. The results of the correlation analyses presented in Table 4.4 shows that 35 of the 66 correlations were statistically significant and were greater than or equal to  $r = .24$ .

Table 4.4

*Correlation Matrix – All Independent and Dependent Variables (n = 225)*

	1	2	3	4	5	6	7	8	9	10	11	12
1 Age	--											
2 Race/Ethnicity	-.14	--										
3 Self-Efficacy	-.04	.01	--									
4 Math Confidence	-.04	-.03	.52*	--								
5 Science Confidence	-.04	-.03	.56*	.52*	--							
6 Math Interest	-.18	.04	.30*	.60*	.18	--						
7 Science Interest	.07	.02	.33*	.20	.67*	.24*	--					
8 Math Teacher Influence	-.09	.09	.34*	.56*	.27*	.51*	.15	--				
9 Science Teacher Influence	.12	.11	.30*	.19	.42*	.20	.55*	.37*	--			
10 Peer Influence Math	-.01	.03	.36*	.39*	.29*	.49*	.34*	.31*	.36*	--		
11 Peer Influence Science	.06	.01	.34*	.16	.43*	.13	.59*	.09	.49*	.69*	--	
12 Parent Encouragement	-.05	.06	.33*	.21	.30*	.24*	.37*	.08	.30*	.41*	.41*	--

*Note: \* $p < .001$  Bonferonni adjustment for multiple correlations to minimize Type I error.*

This study indicated that 9 correlations had a high positive correlation according to Green and Salkind (2011). The relationship between peer influences in science had a high positive correlation with peer influences in math ( $r = .69, p < .001$ ). In other words, students that reported high peer influences in science also had the same experience with their peers in math.

The relationship between science interest and science confidence also showed a high correlation ( $r = .67, p < .001$ ). Math confidence and math interest revealed a high correlation ( $r = .60, p < .001$ ). Another high relationship was discovered between peer influence in science and interest in science ( $r = .59, p < .001$ ). The relationship between math teacher influences and math confidence was also high ( $r = .56, p < .001$ ). Science teacher influences and science interest indicated a high correlation as well ( $r = .55, p < .001$ ). In addition, self-efficacy and math confidence indicated a high positive relationship ( $r = .52, p < .001$ ). Self-efficacy and science confidence also showed the same high correlation ( $r = .52, p < .001$ ). Finally, math teacher influences and math interest indicated a high positive correlation ( $r = .51, p < .001$ ).

Moderate correlations as indicated by Green and Salkind (2011) showed that 21 correlations had a moderate positive correlation. The relationship between peer influences in math and math interest demonstrated a moderate positive relationship ( $r = .49, p < .001$ ). Peer influences in science and science teacher influences also indicated a moderate positive relationship ( $r = .49, p < .001$ ). Also, peer influences in science and science confidence showed a moderate positive correlation ( $r = .43, p < .001$ ). Another correlation that indicated a moderate positive relationship was science teacher influences and science confidence ( $r = .42, p < .001$ ). Parent encouragement and peer influences in both math and science showed moderate positive relationships ( $r = .41, p < .001$ ). The relationship between peer influences in math and math confidence had a moderate positive correlation ( $r = .39, p < .001$ ). Science teacher influences and math teacher influences showed a moderate positive relationship ( $r = .37, p < .001$ ), while parent encouragement and science interest demonstrated a moderate positive correlation as well ( $r = .37, p < .001$ ). Additionally, peer influences in math had a moderate positive relationship with science teacher influences ( $r = .36, p < .001$ ). Peer influences in math also showed a

moderate positive relationship with self-efficacy ( $r = .36, p < .001$ ). The relationship between peer influences in math and science interest indicated a moderate positive relationship as well ( $r = .34, p < .001$ ). Peer influences in science and self-efficacy also showed a moderate positive relationship ( $r = .34, p < .001$ ). Also, math teacher influences and self-efficacy displayed a moderate positive relationship ( $r = .34, p < .001$ ). The relationship between science interest and self-efficacy indicated a moderate positive relationship ( $r = .33, p < .001$ ). Parent encouragement and self-efficacy also presented a moderate positive relationship ( $r = .33, p < .001$ ). Also, peer influences in math and math teacher influences showed a moderate positive relationship ( $r = .31, p < .001$ ). Finally, four relationships were found moderately positive ( $r = .30, p < .001$ ) including math confidence and math interest, science teacher influences and self-efficacy, parent encouragement and science confidence, and parent encouragement and science teacher influences.

There were also 4 correlations that indicated a low positive relationship according to Green and Salkind (2011). Peer influences in math and science confidence showed a low positive relationship ( $r = .29, p < .001$ ), while math teacher influences and science confidence also indicated a low positive relationship ( $r = .27, p < .001$ ). The relationships between science interest and math interest showed a low positive relationship ( $r = .24, p < .001$ ). Additionally, parent encouragement and math interest showed a low positive relationship ( $r = .24, p < .001$ ).

### **Paired Samples *t*-test**

According to Green and Salkind (2011), the paired samples *t*-test “evaluates whether the mean of the difference between two variables is significantly different from zero” (p. 169). In this study, a paired samples *t*-test was conducted to determine if there was a difference between participants’ confidence in math and their interest in math. The results indicate that the mean

difference for math interest ( $M = 19.75$ ,  $SD = 5.61$ ) and math confidence ( $M = 24.60$ ,  $SD = 4.13$ ),  $t(224) = 15.97$ ,  $p < .001$  was statistically significant. Participants reported being slightly more confident in their math skills and knowledge than they were interested in math. The 95% confidence interval for the mean difference between the two was 4.254 to 5.452.

In addition, a paired samples  $t$ -test was conducted to determine if there was a difference between participants' confidence in science and their interest in science. The results indicate that the mean difference for science interest ( $M = 19.59$ ,  $SD = 5.54$ ) and science confidence ( $M = 20.40$ ,  $SD = 3.62$ ),  $t(224) = 2.66$   $p < .01$  was statistically significant. Participants indicated that they were more confident in their skills/knowledge in science than they were interested in science. The 95% confidence interval for the mean difference between the two was .210 to 1.417.

### **Sequential Multiple Regression**

Four sequential multiple regressions were conducted to predict middle school girls' interest and confidence in both math and science. Into block one, the macrosystems of age, race/ethnicity, and the microsystem of self-efficacy were entered. Into block two, which created the full model, the microsystems of teacher influences, parent encouragement, and peer influences were entered. Results for each regression are indicated in a table consisting of the unstandardized regression coefficients ( $b$ ), the standard error for the unstandardized regression coefficient ( $SEb$ ), and the variance ( $R^2$ ). The  $R^2$  is important in this analysis because it is an indicator that assesses "how well the linear combination of predictor variables in the regression analysis predicts the criterion variables" (Green & Salkind, 2011, p. 289).

## Math Confidence

A sequential multiple regression analysis was conducted to predict the confidence of middle school girls' in math. Table 4.5 reports the variables entered in the blocks and the standardized and unstandardized coefficients and their standard errors.

**Math confidence (model 1).** Block 1 consisted of the macrosystems of age, race/ethnicity, and the microsystem of self-efficacy. The results of this analysis indicated that self-efficacy ( $\beta = .516, p < .001$ ) significantly predicted the confidence of middle school girls' in math  $F(3,221) = 27.085, p < .01$ .

**Math confidence (model 2).** In the full model, which contains block 1 and the microsystems of teacher influences, parent encouragement and peer influence, the results indicated that self-efficacy ( $\beta = .323, p < .001$ ) , teacher influences ( $\beta = .415, p < .001$ ) , and peer influences ( $\beta = .140, p < .05$ ) are statistically significantly predictors for the confidence of middle school girls in math,  $F(6,218) = 30.876, p < .001$  accounting for 46% ( $R^2 = .459$ ) of the variance in math interest. Both self-efficacy and math teacher influences were statistically significant at  $p < .001$  as shown in Table 4.5.

Table 4.5

*Sequential Multiple Regression Coefficients for Math Confidence (n = 225),  $R^2 = .459$*

Variable Blocks	<i>b</i>	<i>SE b</i>	$\beta$
Block 1			
Constant	13.013	4.868	
Self-efficacy	.834	.093	.516***
Ethnicity/Race	-.407	.660	-.036
Age	-.159	.369	-.025
Block 2 (Full Model)			
Constant	3.306	4.399	
Self-Efficacy	.522	.092	.323***
Ethnicity/Race	-.801	.574	-.070
Age	.007	.321	.001
Math Teacher Influence	.407	.054	.415***
Parent Encouragement	.013	.057	.013
Peer Influences	.220	.092	.140*

*Note*<sup>1</sup>  $R^2 = .269$  for block 1;  $.459$  for block 2 – full model

*Note*<sup>2</sup> \*  $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$

## Science Confidence

A sequential multiple regression analysis was conducted to predict the confidence of middle school girls' in science. Table 4.6 reports the variables entered in the blocks and standardized and unstandardized coefficients and their standard errors.

**Science confidence (model 1).** Block 1 consisted of the macrosystems age, race/ethnicity, and microsystem of self-efficacy. The results of this analysis indicated that self-efficacy ( $\beta = .563, p < .001$ ) significantly predicted the confidence of middle school girls' in math,  $R^2 = .320, F(3,221) = 34.63, p < .01$ .

**Science confidence (model 2).** In the full model, which contains block 1 and the microsystems teacher influences, parent encouragement and peer influence, the results indicated that self-efficacy ( $\beta = .431, p < .001$ ), teacher influences ( $\beta = .204, p < .001$ ), and peer influences ( $\beta = .185, p < .01$ ) significantly predicted the confidence of middle school girls' confidence in science,  $F(6,218) = 26.171, p < .001$  accounting for 42% ( $R^2 = .419$ ) of the variance in science confidence. Both self-efficacy and science teacher influences were statistically significant at  $p < .001$  as shown in Table 4.6.



Table 4.6

*Sequential Multiple Regression Coefficients for Science Confidence (n = 225),  $R^2 = .419$*

Variable Blocks	<i>b</i>	<i>SE b</i>	$\beta$
Block 1			
Constant	9.135	4.120	
Self-efficacy	.799	.079	.563***
Ethnicity/Race	-.366	.559	-.037
Age	-.138	.313	-.025
Block 2 (Full Model)			
Constant	7.945	3.862	
Self-Efficacy	.612	.081	.431***
Ethnicity/Race	-.672	.526	-.067
Age	-.368	.295	-.066
Science Teacher Influence	.156	.047	.204***
Parent Encouragement	.018	.052	.020
Peer Influences	.263	.090	.185**

*Note*<sup>1</sup>  $R^2 = .320$  for block 1;  $.419$  for block 2 – full model

*Note*<sup>2</sup> \*  $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$

## Math Interest

A sequential multiple regression analysis was conducted to predict the interest of middle school girls' in math. Table 4.7 reports the variables entered in the blocks and the standardized and unstandardized coefficients and their standard errors.

**Math interest (model 1).** Block 1 consisted of the macrosystems age, race/ethnicity, and the microsystem of self-efficacy. The results of this analysis indicated that self-efficacy ( $\beta = .289, p < .001$ ) and age ( $\beta = -.161, p < .001$ ) significantly predicted the interest of middle school girls' interest in math,  $R^2 = .115, F(3,221) = 9.53, p < .01$ .

**Math interest (model 2).** In the full model, which contains block 1 and the microsystems teacher influences, parent encouragement and peer influence, the results indicated that age ( $\beta = -.139, p < .001$ ), teacher influences ( $\beta = .383, p < .001$ ), and peer influences ( $\beta = .345, p < .001$ ) significantly predicted the interest of middle school girls' interest in math,  $F(6,218) = 25.03, p < .01$  accounting for 41% ( $R^2 = .408$ ) of the variance in math confidence. Both teacher influences and peer influences were statistically significant at  $p < .001$  as shown in Table 4.7.

Table 4.7

*Sequential Multiple Regression Coefficients for Math Interest (n = 225),  $R^2 = .408$*

Variable Blocks	<i>b</i>	<i>SE b</i>	$\beta$
Block 1			
Constant	26.442	7.270	
Self-efficacy	.634	.139	.289***
Ethnicity/Race	.214	.986	.014
Age	-1.389	.552	-.161*
Block 2 (Full Model)			
Constant	12.543	6.248	
Self-Efficacy	.043	.130	.020
Ethnicity/Race	-.672	.526	-.067
Age	-1.197	.456	-.139**
Math Teacher Influence	.510	.077	.383***
Parent Encouragement	.072	.080	.053
Peer Influences	.739	.131	.345***

*Note*<sup>1</sup>  $R^2 = .115$  for block 1;  $.408$  for block 2 – full model

*Note*<sup>2</sup> \*  $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$

## Science Interest

A sequential multiple regression analysis was conducted to predict the interest of middle school girls' in science. Table 4.8 reports the variables entered in the blocks and standardized and unstandardized coefficients and their standard errors.

**Science interest (model 1).** Block 1 consisted of the macrosystems age, race/ethnicity, and microsystem self-efficacy. The results of this analysis indicated that self-efficacy ( $\beta = .336$ ,  $p < .001$ ) significantly predicted the interest of middle school girls' in science,  $R^2 = .119$ ,  $F(3,221) = 9.95$ ,  $p < .01$ .

**Science interest (model 2).** In the full model, which contains block 1 and the microsystems teacher influences, parent encouragement and peer influence, the results indicated that teacher influences ( $\beta = .331$ ,  $p < .001$ ) and peer influences ( $\beta = .358$ ,  $p < .001$ ) significantly predicted the interest of middle school girls' in math,  $F(6,218) = 30.789$ ,  $p < .001$  accounting for 46% ( $R^2 = .459$ ) of the variance in science interest. Both teacher influences and peer influences were statistically significant at  $p < .001$  as shown in Table 4.8.

Table 4.8

*Sequential Multiple Regression Coefficients for Science Interest (n = 225),  $R^2 = .462$*

Variable Blocks	<i>b</i>	<i>SE b</i>	$\beta$
Block 1			
Constant	-1.871	7.168	
Self-efficacy	.729	.137	.336***
Ethnicity/Race	.421	.972	.028
Age	.773	.544	.091
Block 2 (Full Model)			
Constant	-5.555	5.698	
Self-Efficacy	.176	.119	.081
Ethnicity/Race	-.389	.776	-.025
Age	.191	.435	.022
Science Teacher Influence	.375	.069	.321***
Parent Encouragement	.137	.076	.102
Peer Influences	.795	.133	.365***

*Note*<sup>1</sup>  $R^2 = .195$  for block 1;  $.462$  for block 2 – full model

*Note*<sup>2</sup> \*  $p < .05$ , \*\*  $p < .01$ , \*\*\*  $p < .001$

## **Research Question Conclusions**

In this section, each of the research questions is answered using the results from the data analysis presented above.

### **Research Question 1 – Demographics**

*What are the demographics of the middle school girls who participated in this research?*

The demographics of the middle school girls include their age and race. In this study there were 225 participants. The ages of the students ranged between 11-13 years with a mean age at 12.29,  $SD = .650$ . The race/ethnicity of the students was predominately white (84.4%).

### **Research Question 2 – Difference in Confidence and Interest**

*Is there a statistically significant difference between middle school girls' a) confidence in math and interest in math, and b) confidence in science and interest in science?*

The results of the paired samples  $t$ -test indicated that there was significant difference between a) interest and confidence in math. Participants were more confident in their skills and knowledge in math than they were interested in math. This test also indicated that there was a significant difference between b) interest and confidence in science. Participants were more confident in their skills and knowledge in science than they were interested in science.

### **Research Question 3 – Interest in Math**

*To what extent do age, race/ethnicity, self-efficacy, parental encouragement, peer influences, and math teacher influence predict middle school girls' (6-7<sup>th</sup> grade) interest in math?*

The results of the sequential multiple regression full model indicated that age, math teacher influences, and peer influence significantly predicted the middle school girls' interest in math.

#### **Research Question 4 – Interest in Science**

*To what extent do age, race/ethnicity, self-efficacy, parental encouragement, peer influences, and math teacher influence predict middle school girls' (6-7<sup>th</sup> grade) interest in science?*

The results of the sequential multiple regression full model indicated that science teacher influences and peer influence significantly predicted the middle school girls' interest in science.

#### **Research Question 5 – Confidence in Math**

*To what extent do age, race/ethnicity, self-efficacy, parental encouragement, peer influences, and math teacher influence predict middle school girls' (6-7<sup>th</sup> grade) confidence in math?*

The results of the sequential multiple regression full model indicated that self-efficacy, math teacher influences, and peer influence significantly predicted the middle school girls' confidence in math.

#### **Research Question 6 – Confidence in Science**

*To what extent do age, race/ethnicity, self-efficacy, parental encouragement, peer influences, and math teacher influence predict middle school girls' (6-7<sup>th</sup> grade) confidence in science?*

The results of the sequential multiple regression full model indicated that self-efficacy, science teacher influences, and peer influence significantly predicted the middle school girls' confidence in science.

Table 4.9 provides a review of the independent variables that are statistically significant predictors for each of the dependent variables in the full model for each regression analysis.

Table 4.9  
*Summary of Regression Analysis – Significant Predictors for Each of the Full Models*

Predictor Variables	Interest in Math	Interest in Science	Confidence in Math	Confidence in Science
Macrosystem Variables				
Age	Yes	--	--	--
Race/Ethnicity	--	--	--	--
Microsystem Variables				
Self-Efficacy	--	--	Yes	Yes
Teacher Influence (Math or Science)	Yes	Yes	Yes	Yes
Peer Influences	Yes	Yes	Yes	Yes
Parental Encouragement	--	--	--	--

### Summary

Chapter 4 discussed the results of the data analysis that included first cleaning the data and testing for normality. Second frequencies and descriptive statistics were conducted to describe the demographics of the participants. Next, paired samples t-tests were run to determine if there was a difference between both confidence and interest in math and confidence and interest in science. Finally, sequential multiple regressions were conducted to determine the predictors of confidence and interest in both math and science. Significant predictors for confidence in both math and science were self-efficacy, math/science teacher influences, and peer influences. For interest in math and science, significant predictors were age (math only), math/science teacher influences, and peer influences. Chapter 5 will provide a summary of the study, implications for policy and practice, and recommendations for future research of the results presented in chapter 4.



## CHAPTER 5

### DISCUSSION, CONCLUSIONS, IMPLICATIONS

*“If we’re going to out-innovate and out-educate the rest of the world, we’ve got to open doors for everyone. We need all hands on deck, and that means clearing hurdles for women and girls as they navigate careers in science, technology, engineering, and math.”*

*-- First Lady Michelle Obama, September 26, 2011*

Chapter 5 provides a detailed summary of the study and discussion of the results as they relate to Bronfenbrenner’s Bioecological Model and current research. Conclusions from those results are discussed, and implications for policy and practice are also addressed. Finally, recommendations for future research and final thoughts are explained.

#### Summary of the Study

Chapter 1 detailed the history of STEM and STEM education including the development of recent policies and strategies designed to encourage more women and minorities to explore and select STEM career opportunities. Both the federal and local perspectives are addressed as they relate to initiatives for STEM careers and STEM education. The statement of the problem was explained in order to justify and support the importance of this study, both locally and globally.

The purpose of this study was to explore potential predictors that influence middle school girls’ interests and confidence in math and science. Determining specific factors that influence girls’ interest in math and science such as self-efficacy, teacher influences, peer influences, and parental encouragement can provide valuable information to educators and parents. Information gained can be used to guide development of programs and policies that work toward encouraging girls’ involvement and retention in STEM programs and activities.

In this study there were six research questions that addressed demographics of the middle school girls' surveyed, the relationship between interest and confidence in both math and science of middle school girls, and the hypothesized predictors of middle school girls' confidence and interest in math and science.

Finally, Chapter 1 provided a description of the conceptual framework, Bronfenbrenner's Bioecological Model, that framed the hypothesized variables that influenced middle school girls' confidence and interest in math and science. These influences include both macrosystems (age, race/ethnicity), and microsystems (self-efficacy, math/science teacher influences, parent encouragement, and peer influences).

Chapter 2 discussed the current literature providing a historical perspective and local perspectives on STEM careers and STEM education. The literature connected to the micro- and macrosystems of Bronfenbrenner's Bioecological Model identified as having a potential impact on a girl's STEM development was reviewed.

Chapter 3 explained the methodology for the study. This study used survey methodology with a theoretical perspective of post-positivism. Additionally, the background of the participants, data collection, and the survey instrument were all addressed. Also, in chapter 3 is a description for each of the factors created for the dependent variables and, where applicable, the independent variables. The chapter closed with the review of the descriptive and inferential data analysis procedures used.

Chapter 4 reported the findings of the analyses. Sequential multiple regressions determined that there were several predictors of middle school girls' confidence and interest in math and science. Some of the most pervasive predictors included self-efficacy, teacher influences, and peer influences.

## **Discussion of the Results**

Nationally, President Obama has garnered support from several organizations such as NASA and the Girls Scouts of America to bolster efforts in getting girls involved in STEM activities. In addition, funding has been granted to schools for STEM initiatives and individuals who enter STEM majors (White House.gov, 2013).

In Iowa, several initiatives are under way to increase awareness and interest in STEM fields. The Governor's STEM Advisory Council (2013) has recently agreed on several priorities for 2013 including college and STEM career readiness, public awareness, student interest and performance, teacher preparedness, and use of technology. Although much is being implemented both nationally and locally to impact the disparity of women in STEM careers, there is much work yet to be done including further research on the topic.

This study concentrated on determining the predictors for middle school girls' confidence and interest in math and science. This study extends the earlier work of Heaverlo (2011) who also focused on identifying predictors for girls STEM development in science and math, by including factored variables for self-efficacy and peer influence as well as creating factored constructs for the dependent variables of math and science interest, and math and science confidence.

The following sections present a discussion of the study's findings within the contexts of Bronfenbrenner's (2005) macrosystems and microsystems identified in this study as age, race/ethnicity, self-efficacy, math/science teacher influences, parent encouragement, and peer influences.

### **Macrosystems**

**Age.** In this study, age was significant in predicting middle school girls' interest in math. Fisher, Dobbs-Oates, Doctoroff, and Arnold (2012) report that students as young as preschoolers show a relationship between math skill and math interest. Therefore, fostering those skills at an early age is critical. According to Gibbons and Boarders (2011), many students choose their careers between 8<sup>th</sup> and 10<sup>th</sup> grade. As a result STEM initiatives must be implemented prior to these grade levels. Cho, Goodman, Oppenheimer, Codling, & Robinson (2009), agree that STEM intervention strategies should be implemented prior to eighth grade.

As girls grow older, they tend to lose interest in math. This study shows a negative impact on math interest as students grow older age ( $\beta = -.161, p < .001$ ). The federal legislative agenda from the Girl Scouts of the USA (2012) reports that girls begin to become disinterested in STEM subjects as they get older. The agenda further explains that girls' interest drops significantly from 4<sup>th</sup> grade to 8<sup>th</sup> grade to 12<sup>th</sup> grade. Girls were asked if they could choose to not study math would they take advantage of that option. In 4<sup>th</sup> grade, 9% of girls reported that they would choose not to study math. In 8<sup>th</sup> grade, 15% of girls reported that they would choose not to study math. And in 12<sup>th</sup> grade, 50% of girls reported that they would choose not to study math. The Girls Scouts of the USA report provides solutions to combat this issue:

- Engage and motivate girls.
- Provide girls with mentors and role models.
- Support hands-on activities and inquiry-based learning.
- Build relationships with business and industry to expand opportunities for girls.

The U.S. Department of Labor (2013) forecasted that STEM careers will grow dramatically; however, teenage girls are showing less interest in STEM fields. A national sample of teenagers was surveyed by the U.S. Department of Labor (2013) to determine interest in STEM careers.

Only 16% of the girls expressed an interest in STEM careers, which is a decline from the previous years' 21%.

**Race/Ethnicity.** In this study race/ethnicity was not a significant predictor of middle school girls' interest or confidence in math or science. This finding may be encouraging in that girls who identify with a race/ethnicity other than white are not less interested or less confident in math or science than their white counterparts. This finding confirms Heaverlo's (2011) results which also indicated that race/ethnicity was not a significant predictor of girls' interest or confidence in math or science.

The U.S. Census Bureau projects that half of the nation's population will consist of minority races. Despite the results of this study, which report that race/ethnicity was not a negative predictor for interest or confidence in math and/or science, Museus, Palmer, Davis, and Maramba (2011) point to k-12 education as being the culprit for the disparity of minorities in STEM. Some reasons for this are the lack of funding for those schools who serve large minority populations, too many unqualified teachers serving those schools, lack of Advanced Placement, and minority students tracked into lower level and remedial courses (Museus, Palmer, Davis, & Maramba, 2011).

Although there seem to be disparities, there are factors that positively contribute to the success of minority students (Museus, et.al., 2011).

- Parent encouragement and support.
- Bilingual education.
- STEM exposure at an early age.
- Self-efficacy focus in STEM subjects.
- More STEM opportunities and programs.

- Higher level of interest in STEM career.

## **Microsystems**

**Self-Efficacy.** This study sheds light on the role that self-efficacy plays in the confidence and interest of middle school girls in relation to their confidence in math and science. For the participants in this study, self-efficacy significantly predicted middle school girls' confidence in math and confidence in science, but not their interest in math or science. This finding has implications regarding how to impact girls' confidence in math and science through self-efficacy at the middle school level.

According to Bandura (1997), self-efficacy beliefs were the most prevailing influence on a person's decision to begin and continue in a certain behavior. The connection between self-efficacy and career development in adolescents is well documented (e.g., Hackett, Betz, Casas, & Rocha-Singh, 1992; Pajares & Miller, 1995). According to Bandura & Wood (1989), it is important to teach skills related to specific interventions such as:

- Goal-setting
- Planning
- Self-regulatory processes
- Academic motivation

Dweck, 2007, suggests praising girls for their effort as well as praising girls for answering the questions correctly helps increase both confidence and interest through self-efficacy. Many students feel as though they do not have a natural ability to excel at math and science; therefore, emphasizing hard work rather than being genetically gifted, helps girls believe that they can be successful at math and science. Dweck, 2007, further provides evidence that that having a growth mindset rather than a fixed mindset improves self-efficacy and

performance. This growth mindset is crucial for middle school girls as well as women in college to protect them from side effects of the cultural stereotypes that boys are better at math than girls (Dweck, 2007).

Vancouver & Kendell, 2006, demonstrates the connection between low prior performances to self-efficacy development. In other words, if a student has a poor experience in math or science at a younger age, this can impact self-efficacy as a child moves forward in his/her or an educational career. Rittmayer and Beier (2012) suggest the following to develop and enhance STEM self-efficacy:

- Integrate hands-on activities and inquiry labs and projects that encourage self-regulation in the course.
- Differentiate instruction to meet the students' needs.
- Structure activities to meet specific goals.
- Focus on the mastery of standards.
- Provide formative feedback and encouragement.
- Inform parents of the importance of supporting and encouraging their daughters
- Introduce STEM role models into the lives of girls to make an impact on self-efficacy.
- Educate students on the importance of females in STEM careers.

**Math/Science Teacher Influences.** In this study, math and science teacher influences were significant predictors of both confidence and interest in math and science. Such a strong predictor should be taken seriously and capitalized on by educators. Heaverlo (2011) also found that teacher influences significantly predicted both confidence and interest in math and science.

According to Heaverlo (2011) and the findings in this study, several measures can be taken by the teacher in the classroom to increase interest and confidence of girls:

- Communicate high expectations.
- Provide a positive classroom environment.
- Provide feedback to students.
- Encourage responsibility and effort.
- Use a variety of classroom activities and resources.
- Encourage students to apply what they know to outside situations.
- Discuss careers related to STEM.

President Obama announced a goal of recruiting 10,000 new STEM teachers in order to meet the demand of growing STEM careers (White House, 2010). These teachers must be trained in STEM literacy, quality math and science instruction, and a focus on under-represented group such as women and minorities to be effective (White House, 2010). According to McCarthy & Slater (2011), additional ways teachers can impact middle school girls' interest and confidence in math and science include creating ways for human connections and design elements to introduce more creativity into the curriculum. This could mean allowing girls in a pre-engineering/architecture program to design an innovative walk-in closet, which would appeal to their design interest and creativity. Another example could include creating a video game targeted to young girls since there are not many video games for young girls. Other teaching strategies impacting girls include providing group learning activities, giving students choices, and supporting positive inquiry (McCarthy & Slater, 2011). Cooper and Heaverlo (2013) found that interest in problem solving activities in the classroom, as well as an interest in creativity and



design, significantly predicted girls' interest in the STEM subject areas of math, science, engineering, and computers.

AAUW (2010) report that teachers can have a significant impact on interest in math and science by implementing the following strategies in the classroom:

- Promoting a growth mindset.
- Exposing girls to female role models in STEM careers.
- Assist girls in seeing their career-relevant skills.
- Encourage girls to take high level math and science courses.
- Make performance standards clear.

**Parent Encouragement.** Although parent encouragement was not a significant predictor for the participants in this study, other studies have demonstrated the importance of parent encouragement related to academics. Rowan-Kenyon, et al., (2010) report that both adolescent girls and teachers find that parent involvement makes a difference in academic achievement. According to Lupkowski-Shoplik and Piskurich (2011), parents can impact girls' achievement by:

- Be an active role model for learning.
- Set aside time daily to talk about learning.
- Travel with your daughter. This provides authentic learning experiences and boosts confidence.
- Attribute girls' successes to their ability, not just hard work.
- Direct energy toward positive activities.
- Encourage girls to participate in all-girl activities to promote peer influence.

AAUW (2010) also suggests that parents have a significant impact on their daughters' interest in both math and science. Parents should avoid negative stereotypes that effect girls' self-efficacy. Intentionally focusing on countering these stereotypes will ultimately lead to higher performance and interest in math and science (AAUW, 2010). Parents should also cultivate an environment that encourages girl's success in math and science. Discussing role models, encouraging girls to take higher level math and science classes, and fostering a growth mindset, are all ways that parents can assist in their success in STEM subjects (AAUW, 2010).

**Peer Influences.** In this study, peer influences were a significant predictor for all four dependent variables, confidence in math and science, and interest in math and science. When determining group and partner work, this should be taken into consideration. The Williams Project on the Study of Economics in Higher Education (2012) reported a correlation between students who are strong academically and a positive impact on their peer group. Liem and Martin (2011) found that same gender peer relationships significantly predicted academic performance and that same gender peer relationships have a more positive influence on school engagement. Strategies to have a positive impact on peer influences could include providing more opportunities for partnering and group activities with peers. With that being said, teachers have an important role in providing productive group work activities to encourage peers working together.

Nelson & DeBacker (2008) also discussed peer climate variables, which predicted both performance goals and self-efficacy. Therefore, when peer climate is positive toward math then students will perform better on math tasks and self-efficacy in math is positive. This study provides further merit for providing a culture of positive peer interactions.

### **Implications for Policy and Practice**

This study is a small part of a more systemic issue with the goal of increasing the number of girls pursuing STEM academic programs and ultimately STEM careers. Taking higher level math and science courses starting in middle school and moving up into high school will help to prepare girls for STEM college majors and STEM careers. The final goal is to increase the number of women in STEM careers. This focus must shift to middle school since research has shown (Gibbons & Boarders, 2011) that high school students are already set on a pre-determined path in their math and science curriculum based on middle school performance. Acceleration must start sooner, and providing authentic STEM related learning experiences must begin at an early age to get girls excited about STEM careers. Several additional recommendations are listed below.

### **Recommendations for Teachers**

Because teacher influences were a significant predictor of both confidence and interest in math and science, there are several strategies that teachers can employ to make and impact on middle school girls.

- Provide female role models in STEM careers for young girls.
- Create additional opportunities to introduce girls to STEM careers.
- Integrate STEM concepts across the curriculum.
- Offer science fair opportunities.
- Require or encourage girls to take pre-engineering classes such as Project Lead the Way.
- Productive group work opportunities with peers
- Project-Based learning in math and science

- Partnering with business and industry on real-world projects
- Hyperstreaming to encourage after school STEM programming
- STEM Forum for middle school girls to connect STEM education to careers using female role models

### **Recommendations for Schools and Districts**

Because districts have a systemic perspective of the instructional operation of schools, it is vital that districts approach STEM initiatives from a purposeful and systemic lens. Districts can impact STEM education dramatically by making the following programming decisions:

- Integrate STEM concepts across the curriculum during curriculum review.
- Provide additional STEM opportunities for girls such as a systemic STEM Expo.
- Focus district goals on STEM initiatives.
- Cultivate community partners to work with schools on STEM curriculum.
- Provide professional learning to teachers on STEM and integrating STEM concepts into curriculum.
- Provide acceleration options.

### **Recommendations for Parents**

Since this study has indicated a moderate positive correlation between self-efficacy and parent encouragement, it is important to provide suggestions and guidance on how to influence girls' perceptions of STEM classes and careers.

- Encourage girls to take higher level math and science classes at a younger age.
- Follow up on girls homework and them what they are learning in class.
- Discuss post-secondary options in STEM.
- Talk to the girls about STEM careers.

- Encourage STEM volunteer or work opportunities for girls.
- Look for authentic STEM experiences for girls.

### **Recommendations for Middle School Girls**

Because peer influences were statistically significant in predicting math confidence, science confidence, math interest, and science interest, students must be aware of friend choice. Peer influences and self-efficacy also indicated a moderate positive correlation suggesting that peers influence girls' self-efficacy. Strategies that girls should consider include the following:

- Choose high achieving friends.
- Seek out STEM opportunities.
- Register for higher level math and science classes.
- Participate in career fairs and science fairs at school.
- Participate in STEM competitions.
- Participate in volunteer opportunities.

### **Recommendations for Future Research**

This study adds to the current literature focused on solutions aimed at increasing the number of women in the STEM careers. Recommendations for future research include: studying the predictors that impact confidence and interest for middle school boys to determine if they are the same predictors impacting confidence and interest for middle school girls. Another recommendation for future research would be to broaden the participant pool beyond the Midwest to determine if results are similar.

It would also be interesting to conduct a longitudinal study surveying these same groups of girls in high school, college, and then during their career. This type of study would allow

insights on the developmental changes these young girls experience at different stages in their growth as they relate to interest in math and science.

Since there are studies that suggest math and science interest is related to skill acquisition at an early age, STEM related studies should be conducted on elementary students. These studies should be segregated k-2 and 3-5 since students are very developmentally different at these ages.

### **Conclusion**

This study explored the predictors of middle school girls' confidence and interest in math and science in order to determine how to encourage young women to ultimately aspire toward STEM careers. Using Bronfenbrenner's Bioecological Model to guide the study, it was determined that several of the microsystems were statistically significant in the confidence and interest of middle school girls' in math and science. Specifically, the variables self-efficacy, teacher influence, and peer influence were the primary predictors for confidence and interest in math and science. Because there were several variables that were significant in this study, there is much that can be done to impact girls at the middle school level in terms of interest and confidence in math and science. It is also encouraging that self-efficacy, teachers, and peers have a significant impact on confidence and interest in math and science. Each of these variables can be impacted greatly in the classroom by implementing programming and strategies

### **Final Thoughts**

The economic need for increasing the involvement of women in STEM careers is pervasive at this point in time. Finding the most appropriate way to leverage this challenge is vital to the success of getting more young women interested in STEM careers. It is interesting how interconnected many of the variables are when examining possible solutions. Self-efficacy

impacts confidence which impacts interest. Therefore, one possible solution can impact all three variables. It is also exciting that many of these solutions are found right in the classroom.

Therefore, providing effective training to our teachers in math and science is critical. Discussing ways to increase self-efficacy with counselors and teachers will impact both girls' confidence and interest in math and science. Finally, providing resources for parents on how to encourage their daughters in math and science is beneficial.

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## APPENDIX A

### Assent Form

Dear Middle School Student:

The purpose of the survey you are being asked to take is to help me gather information about your experiences with Science and Math education in middle school. You are being invited to take this survey because you are a middle school student at Prairie Ridge or Parkview. There will be no direct benefits to you for completing the survey. However, the information gathered from this survey will be beneficial in helping to guide programs and policies designed to encourage and retain more students in STEM programs and activities. Results of this study may be published in journals and/or presented at conferences.

If you agree to participate in taking the survey, your participation will last for only the time it takes you to complete the attached survey, which should be about 15 minutes. Your participation is completely voluntary and you may choose not to complete the survey and/or skip any questions that you do not want to answer. Your participation is confidential and there will be no way of linking your responses back to you. Risks involved for participating in this study are very minimal, such as, discomfort with some survey questions (e.g., I am comfortable seeking help when I have questions about this subject). You may skip any questions that you do not want to answer. If you chose not to complete the survey, it will not affect you at school in any way. The survey will include questions about your interests and confidence in math and science, as well as teacher, parent, and peer support and influences as they relate to math and science.

If you have any questions about completing the survey, please contact me using the information below.

If you agree to participate in this study, please sign:

Student \_\_\_\_\_ Date \_\_\_\_\_

Thank you! ☺

Tabby Rabenberg  
Principal  
Prairie Ridge Middle School  
1010 Prairie Ridge Drive  
Ankeny, IA 50023  
Phone: (515) 965-9705

## APPENDIX B

### Consent Form

Dear Parent/Guardian:

As a middle school Principal in Ankeny, I will be asking participants to complete a brief survey. The purpose of the survey is to gather information about your child's experiences with Science, Technology, Engineering, and Math (STEM) education in middle school. The information collected from the survey will be used for my doctoral dissertation.

As a participant in this study, your child will be asked to complete a survey in advisory group. Participation in the study is estimated to take about 15 minutes. There will be no direct benefits to you or your child from participating in this study. However, the information gathered from this survey will be beneficial in helping to guide programs and policies designed to encourage and retain more students in STEM programs and activities. The following are the terms of participating in this study:

- The information obtained during this study will be used to write my doctoral dissertation and results may be published in journals and/or presented at conferences. Your child's responses to the survey will not be included in the analysis without your signed written consent as noted below.
- Risks involved for participating in this study are very minimal, such as, discomfort with some survey questions (e.g., I am comfortable seeking help when I have questions about this subject). Your child may skip any questions that they do not want to answer.
- Names of participants (your child) will not be used in this study; however, aggregated demographic information will be reported. All data will be secured in a password protected computer and paper surveys will be secured in a locked file cabinet.
- Participation in this study is voluntary and will last only for duration of completing the survey (approximately 15 minutes). You or your child has the right to withdraw at any time from the study, for any reason, and the data will be returned to you upon request.
- All participants will have access to the doctoral dissertation through Drake University upon completion.

If you consent to allow your child to participate in this research study according to the above terms, please sign:

Parent/Guardian \_\_\_\_\_ Date \_\_\_\_\_

Thank you,

Tabby Rabenberg  
Principal  
Prairie Ridge Middle School  
1010 Prairie Ridge Drive  
Ankeny, IA 50023  
Phone: (515) 965-9705



## APPENDIX C

### STEM Student Survey

**Please read these directions carefully and ask questions if you are unsure how to answer.**

**Directions:** For each statement listed below, please circle the number that matches your level of agreement with each statement. You should have two numbers circled for each statement. One answer that reflects your agreement with the statement as it relates to your math class under the **math column** and one answer that reflects your agreement with the statement as it relates to your science class under the **science column**.

**Scale: 1=Strongly Disagree, 2=Disagree; 3 = Neutral; 4 = Agree, and 5=Strongly Agree**

	Statements	Math Class						Science Class				
1	I enjoy learning the material in this class.	1	2	3	4	5		1	2	3	4	5
2	I look forward to coming to class because of my interest in this subject.	1	2	3	4	5		1	2	3	4	5
3	I am happier in this class than any other class.	1	2	3	4	5		1	2	3	4	5
4	I plan to take as many classes in this subject as possible.	1	2	3	4	5		1	2	3	4	5
5	I would like to avoid this subject if possible.	1	2	3	4	5		1	2	3	4	5
6	I look for ways to learn more about this subject.	1	2	3	4	5		1	2	3	4	5
7	I look for or participate in activities related to this subject.	1	2	3	4	5		1	2	3	4	5
8	I can succeed in finishing all my homework for this class every day.	1	2	3	4	5		1	2	3	4	5
9	I am comfortable seeking help when I have questions about this subject.	1	2	3	4	5		1	2	3	4	5
10	Studying this subject makes me feel nervous/anxious.	1	2	3	4	5		1	2	3	4	5
11	I am confident that I can learn this subject.	1	2	3	4	5		1	2	3	4	5
12	I am successful in understanding all the material in this class.	1	2	3	4	5		1	2	3	4	5
13	When I get stuck on a question, I can usually get it.	1	2	3	4	5		1	2	3	4	5
14	My teacher creates a classroom environment that allows me to learn.	1	2	3	4	5		1	2	3	4	5
15	In class, we use a variety of classroom activities and resources to help me learn this subject.	1	2	3	4	5		1	2	3	4	5
16	My teacher encourages us to apply what we've learned to situations outside of class.	1	2	3	4	5		1	2	3	4	5
17	My teacher encourages us to ask questions.	1	2	3	4	5		1	2	3	4	5
18	My teacher communicates high expectations.	1	2	3	4	5		1	2	3	4	5
19	My teacher encourages my responsibility and effort.	1	2	3	4	5		1	2	3	4	5
20	I am comfortable asking my teacher questions about this	1	2	3	4	5		1	2	3	4	5

	subject.											
21	My teacher asks questions that challenge me to think.	1	2	3	4	5		1	2	3	4	5
22	I get helpful feedback from my teacher.	1	2	3	4	5		1	2	3	4	5
23	My teacher tells the class about resources that will help us learn this subject.	1	2	3	4	5		1	2	3	4	5
24	My teacher talks about possible careers that relate to this subject.	1	2	3	4	5		1	2	3	4	5

Over &gt;

Scale: 1=Strongly Disagree, 2=Disagree; 3 = Neutral; 4 = Agree, and 5=Strongly Agree

	Statements	1=Strongly Disagree, 2=Disagree; 3 = Neutral; 4 = Agree, and 5=Strongly Agree				
25	I can express my opinions when other classmates disagree with me.	1	2	3	4	5
26	I can tell my classmates or friends that they are doing something that I don't like.	1	2	3	4	5
27	I can succeed in understanding all subjects in school.	1	2	3	4	5
28	I set high expectations for myself.	1	2	3	4	5
29	My parents/guardians discuss selecting math and science courses with me.	1	2	3	4	5
30	My parents/guardians discuss things I have studied in math or science class.	1	2	3	4	5
31	My parents/guardians encourage me to take more math or science courses.	1	2	3	4	5
32	My parents/guardians talk to me about future careers that involve my learning math or science.	1	2	3	4	5
33	My friends encourage me to take more or higher level math courses.	1	2	3	4	5
34	My friends encourage me to take more or higher level science courses.	1	2	3	4	5
35	My friends like math.	1	2	3	4	5
36	My friends like science.	1	2	3	4	5
37	My friends do well in math.	1	2	3	4	5
38	My friends do well in science.	1	2	3	4	5

39. I am: \_\_\_\_\_ Boy \_\_\_\_\_ Girl

40. My grade is: \_\_\_\_\_

40. My age is: \_\_\_\_\_

41. What is your race/ethnicity: \_\_\_\_\_

\_\_\_\_\_Caucasian  
\_\_\_\_\_African American  
\_\_\_\_\_Asian/Pacific Islander  
\_\_\_\_\_Latina/Hispanic  
\_\_\_\_\_American Indian/Alaskan Native  
\_\_\_\_\_Bi-racial/mixed race  
\_\_\_\_\_Other\_\_\_\_\_

42. What future occupations are you interested in?

\_\_\_\_\_

**Thank you for completing the survey!**